CR 151661

SHUTTLE ENVIRONMENTAL AND THERMAL
CONTROL/LIFE SUPPORT
SYSTEM COMPUTER PROGRAM

FINAL REPORT

BY

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Prepared under contract NAS 9-14913
by

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for

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

(NASA-CR-151661) SHUTTLE ENVIRONMENTAL AND THERMAL CONTROL/LIFE SUPPORT SYSTEM COMPUTER PROGRAM Final Report (Hamilton Standard, Windsor Locks, Conn.) 83 p HC A05/MF A01 CSCL 06K

N78-20175

Unclas
G3/16 11817

February 1978

ABSTRACT

Shuttle Environmental and Thermal
Control/Life Support System Computer
Program

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Contract NAS 9-14913

February 1978

This users guide describes the computer programs developed to aid in the analysis of RSECS (Representative Shuttle Environmental Control System) related material. These programs have been prepared to provide pretest predictions, post-test analysis, and real-time problem analysis for RSECS related test planning and evaluation. The programs have been designed for use on a Wang 2200 series computer system. Hamilton Standard has provided these programs to the NASA on magnetic tape cassette cartridges and on a disk device that is part of Crew Systems Division's Wang 2200 series computer system.

FORWARD

This report has been prepared by the Hamilton Standard Division of United Technologies Corporation for the National Aeronautics and Space Administration's Lyndon B. Johnson Center in accordance with the requirements of Contract NAS 9-14913, Shuttle/RSECS Computer Program. This report covers work accomplished during calendar years 1977 and January through February of 1978. Previous report CFS-401, "Interim Progress Report" covered work performed under this contract during calendar year 1976. Appreciation is expressed to the NASA JSC Technical Monitor, Mr. James Jaax, for his support during the conduct of this program.

The Hamilton Standard technical personnel responsible for the work described herein is Mr. Ernest E. Smith, Jr. The program manager is Mr. Harlan E. Brose

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

To fulfill the requirements of Contract NAS 9-14913, for calendar year 1977, Hamilton Standard has developed the computer programs listed below. These programs were written to support RSECS related analysis.

- "SUITSK2" - Calculates the steady state parameters of the EMU (Extravehicular Mobility Unit) for the IVA (Intravehicular Activity) mode when it interfaces with the Shuttle environmental control system. The program also calculates the EMU parameters in the EVA (Extravehicular Activity) mode. Because of its size, the program does not provide for a printout of the results. This function is provided by program "SUITOUT".

- "SUITOUT" - Provides the printout of the parameters calculated in "SUITSK2" program. The printout is provided in a tabularized format and an optional flowchart format.

- "LIOHPPC" - Plots the partial pressure of CO_2 at the upper and lower LiOH canister outlets and the ARS inlet versus time. The partial pressures of CO_2 were provided by the RSECS LiOH test data. The program stores the input data on cassette tapes and provides an optional printout of the data in a tabularized format.

- "LIOHCRT" - Plots the instantaneous removal rate of CO_2 from the LiOH canisters. The program produces a separate plot for the upper and the lower canisters using the RSECS LiOH test data previously stored on cassette tapes by the "LIOHPPC" program.

- "LIOHMAC" - Plots the accumulation of CO_2 in the LiOH canisters versus time. The program produces a separate plot for the upper and lower LiOH canisters using the RSECS LiOH test data previously stored on cassette tapes by the "LIOHPPC" program.

- "BLOCKF" - Numerically approximates the radiation view factor between a rectangle and an N-sided polygon. The program operates on two surfaces at a time and will not include the effects of a shadowing surface.

- "SCRIPTF" - Calculates radiation exchange factors from a user provided view factor matrix, area vector, and emitance vector.

SUITSK2 STEADY STATE COMPUTER PROGRAM

File Name "SUITSK2"

Abstract "SUITSK2" calculates the steady state temperatures, pressures, flow rates, and heat loads around both the air and water loops of the EMU (Extravehicular Mobility Unit) for both the IVA (Intravehicular Activity) and the EVA (Extravehicular Activity) modes. Steady state solutions can be achieved for a range of metabolic rates and heat leaks which simulate anticipated operational requirements. The program is designed for use with the Wang 2200 series computer system.

Program Description

The program was written in Fortran by Hamilton Standard to assist in EMU performance analysis. The program has been converted into Basic and split into two separate programs for use on the Wang 2200 system. The first of the two Wang programs ("SUITSK2) requests input data and performs calculations, the second ("SUITOUT") prints out the results. The original Hamilton Standard program has been through several revisions. The version of the program which was translated into Basic was "SUITSK2" which was the latest available version.

The program typically works in the "no sweating" mode. Skin temperature is a function of total metabolic rate. If the system cannot meet the heat removal requirements, a sweating mode is initiated. The maximum sweating rate is determined by the maximum relative humidity leaving the suit (an input value). If the heat removal rate can still not be met with sweating, the program reduces the total metabolic heat load until the system can handle the heat load. The difference in total metabolic heat loads must be handled by the man as stored heat.

It should be noted that only one skin temperature can occur at a given metabolic rate. In actuality, a range of skin temperatures are possible at each metabolic rate. The program is presently using the maximum skin temperature (sweating threshold) vs. metabolic rate.

The program attempts to fix the LCG heat load from the man as a function of metabolic work rate approximating available NASA test data. The balance of the heat load is then split between the suit sensible and suit latent heat loads. At higher suit pressures, the sensible heat load is so high that QLCG must deviate from the curve in order to maintain a heat balance.

The water loop heat exchanger, the suit, and sublimator when used as a heat exchanger, are all handled as counterflow heat exchangers (Q = UA x DTLM). The sublimator is actually a cross flow heat exchanger but due to the high mass flow ratio $(W_{cp})H_2O/W_{cp})AIR)$, it can be considered to be counterflow.

The program adjusts sublimator water loop conductances for sublimator water loop flow rate and average temperature.

The program converges on two variables and must go a minimum of four iterations. The convergence variables are:

1) Suit inlet gas temperature
2) Skin temperature

If the above variables are within tolerance for two successive iterations, the program is considered converged.

Two special functions, DEFFN1 and DEFFN2, are included in the program. DEFFN1 calculates a saturation pressure in psia based upon a saturation temperature in degrees F. The function was derived from a sixth order regression of the steam tables. DEFFN2 calculates a saturation temperature in degrees F based upon the log of 10 times the saturation pressure in psia. The function is based upon a subroutine "KANDK" used by the original Fortran version of the program.

The input data is identified in Table I and is requested by the CRT at the beginning of the program execution. Table I also identifies typical input data for a variety of runs. Before actual calculations begin, the input data is printed out so that it can be verified. An example of the input data printout is shown in Figure 1.

Next, the CRT asks whether an optional diagnostic printout is desired. The diagnostic printout provides an incremental printout of the variables as they are calculated. Otherwise, interum variable calculations are not printed out. The diagnostic printout is usually not required, however, when difficulties occur during a run, a rerun with a diagnostic printout will aid in identifying the problem.

The program iterates until either an error occurs, the maximum number of iterations is reached (50 iterations), or the convergence criteria is met. The first two conditions will result in an error message on the CRT, while the latter will result in a loops converged message on the CRT. At this time, the CRT will instruct the user to load the second program ("SUITOUT") A listing of "SUITSK2" is provided in Table II. Table III provides a cross reference between the original Fortran variable names and the Basic variable names in the event that further program changes are required.

Figure 1 SUITSK2 PROGRAM EXAMPLE OUTPUT

```
SUITSK2 PROGRAM RUN


PROGRAM INPUT DATA:

QMETT,QENV,QFAN,QPUMP= 1000  0  11  145
PTOT,PCO2,CFM,WH2O,UAST= 15.2  9.67000000E-03  6.6  185  60
TWI,WCPW,CLIOH,CL2= 45  600  6  3.2
CL3,CL4,RH= 15  50  .9
TFI,TSUBO,XKEY,UAX,WLIOH,AP,UAW= 115  50  1  864.6  21  .2361  601
RFIN,HAGAS,CDP,UAHEL= 471.6  16.28  5.42000000E-03  .4
TSKINT,QDCMEN,QDCMEL,QEVCS,QPLSEN,INC= 95.25  0  27  41  0  1
```

TABLE 1 SUITSK2 INPUT DATA DEFINITION

NAME	DESCRIPTION	TYPICAL VALUES	UNITS
QMETT	TOTAL METABOLIC LOAD	UI*	BTU/HR
QENV	ENVIRONMENTAL HEAT LOAD TO SUIT	UI	BTU/HR
QFAN	FAN POWER TO AIRSTREAM	UI	BTU/HR
QPUMP	PUMP POWER HEAT LOAD	UI	BTU/HR
PTOT	TOTAL PRESSURE - GAS	UI	PSIA
PCO2	CO2 PARTIAL PRESSURE INTO SUIT	.00967	PSIA
CFM	FAN VOLUME FLOW RATE	UI	FT^3/INCH
WH20	PUMP FLOW RATE (H20)	UI	LBS/HR
UAST	UA OF LCG (H20)	UI	BTU/HR-F
TWI	COOLANT H20 INLET TEMPERATURE TO SUBLIMATOR	45	F
WCPW	COOLANT H20 MASS FLOW RATE IN VEHICLE HX	600	BTU/HR-F
CLIOH	CONDUCTANCE BETWEEN LIOH AND CANISTER	6	BTU/HR-F
CL2	CONDUCTANCE BETWEEN GAS AND CANISTER	3.2	BTU/HR-F
CL3	CONDUCTANCE BETWEEN CANISTER AND WATER LOOP	15	BTU/HR-F
CL4	CONDUCTANCE BETWEEN LIOH AND GAS STREAM	50	BTU/HR-F
RH	MAXIMUM RELATIVE HUMIDITY LEAVING SUIT	.9	--
TFI	GUESS OF FAN INLET TEMPERATURE	115	F
TSUBO	GUESS OF GAS SUIT INLET TEMPERATURE	50	F
XKEY	TYPE OF SYSTEM - 1=IVA, 2=EVA	UI	--
UAX	UA OF VEHICLE HX	864.6	BTU/HR-F
WLIOH	H20 FLOW TO LIOH CANISTER FOR COOLING	UI	LBS/HR
AP	POROUS PLATE AREA	.2361	FT^2
UAW	UA OF H20 LOOP IN SUBLIMATOR	UI	BTU/HR-F
RFIN	SUBLIMATOR FIN RESISTANCE	471.6	BTU/HR-F
HAGAS	UA OF GAS LOOP IN SUBLIMATOR	UI	BTU/HR-F
CDP	PRESSURE LOSS BETWEEN SUIT INLET TO FAN INLET	.00542	PSI/(LBS/HR)$^{1.3}$
UAHEL	HELMET CONDUCTANCE TO INLET GAS STREAM	.4	BTU/HR-F
TSKINT	INITIAL SKIN TEMP AT REST	UI	F
QDCMEN	ENVIRONMENTAL HEAT LOAD TO DCM	UI	BTU/HR
QDCMEL	ELECTRICAL HEAT LOAD TO DCM	UI	BTU/HR
QEVCS	ELECTRICAL HEAT LOAD TO EVCS	UI	BTU/HR
QPLSEN	ENVIRONMENTAL HEAT LOAD TO PLSS	UI	BTU/HR
INC	INC-FACTOR TO ALTER SUBLIMATOR UA (TYPICALLY EQUAL TO 1)	UI	--

*UI=user input. The user must define required values.

TABLE II SUITSK2 PROGRAM LISTING

```
10 REM SUITSK2 PROGRAM
20 COM Q1(53),Q2(18),Q3(19),Q4(8),Q5(8),Q6(14)
30 COM U1(4),A1,A2,B,C,C1,C2,C3,C4,C5,D,D1,D7,E1,E2,G1,H1,K
40 COM P1(2),P2(16),P3(7),P4(6),Q6,Q8,R1,R5,R6,S,T1,R4
50 COM W1(19),W2(1),W3(1),U1,U2,U3,U4,U5,U6,U7,U8,U9,V2,V5,W4,W5
60 COM T1(24),T2(7),T3(12),T4(29),T5(2),T6(2)
70 COM V1(17),V2(8),V3(16),V4(7),I
80 DIM Y(4,4),Z(4,1),X(4,1),I(4,4)
90 DEFFN1(X)=2.78076237E-02+5.13243277E-04*X+3.98156450E-05*X↑2-
4.66483844E-08*X↑3+4.91065757E-09*X↑4-1.77954114E-12*X↑5+4.63530
688E-14*X↑6
100 DEFFN2(X)=35.15789+24.592588*X+2.1182069*X↑2-.3414474*X↑3+.1
5741642*X↑4-.031329585*X↑5+.0038658282*X↑6-.00024901784*X↑7+.000
0068401559*X↑8
110 PRINT "TOTAL METABOLIC LOAD":INPUT Q1(8)
120 PRINT "ENVIRONMENTAL HEAT LOAD TO SUIT":INPUT Q5(8)
130 PRINT "FAN POWER TO AIRSTREAM":INPUT Q6(13)
140 PRINT "PUMP POWER HEAT LOAD":INPUT Q6(14)
150 PRINT "TOTAL PRESSURE - GAS":INPUT P1(2)
160 PRINT "CO2 PARTIAL PRESSURE INTO SUIT":INPUT P3(1)
170 PRINT "FAN VOLUME FLOW RATE":INPUT C5
180 PRINT "PUMP FLOW RATE (H2O)":INPUT W1(1)
190 PRINT "UA OF LCG (H2O)":INPUT U1
200 PRINT "COOLANT H2O INLET TEMPERATURE TO SUBLIMTOR":INPUT T4(
8)
210 PRINT "COOLANT H2O MASS FLOW RATE IN VEHICLE HX":INPUT W2(1)
220 PRINT "CONDUCTANCE BETWEEN LIOH AND CANISTER":INPUT C1
230 PRINT "CONDUCTANCE BETWEEN GAS AND CANISTER":INPUT C2
240 PRINT "CONDUCTANCE BETWEEN CANISTER AND WATER LOOP":INPUT C3
250 PRINT "CONDUCTANCE BETWEEN LIOH AND GAS STREAM":INPUT C4
260 PRINT "MAXIMUM RELATIVE HUMIDITY LEAVING SUIT":INPUT H1
270 PRINT "GUESS OF FAN INLET TEMPERATURE":INPUT T1(13)
280 PRINT "GUESS OF GAS SUIT INLET TEMPERATURE":INPUT T1(5)
290 PRINT "TYPE OF SYSTEM - 1=IVA,2=EVA":INPUT K
300 PRINT "UA OF VEHICLE HX":INPUT U2
310 PRINT "H2O FLOW TO LIOH CANISTER FOR COOLING":INPUT W1(19)
320 PRINT "POROUS PLATE AREA":INPUT A1
330 PRINT "UA OF H2O LOOP IN SUBLIMATOR":INPUT U3
340 PRINT "SUBLIMATOR FIN RESISTANCE":INPUT R1
350 PRINT "UA OF GAS LOOP IN SUBLIMATOR":INPUT U4
360 PRINT "PRESSURE LOSS BETWEEN SUIT INLET TO FAN INLET":INPUT
P4(1)
370 PRINT "HELMET CONDUCTANCE TO INLET GAS STREAM":INPUT U5
380 PRINT "INITIAL SKIN TEMP AT REST":INPUT T3(1)
390 PRINT "ENVIRONMENTAL HEAT LOAD TO DCM":INPUT Q1(9)
400 PRINT "ELECTRICAL HEAT LOAD TO DCM":INPUT Q1(10)
410 PRINT "ELECTRICAL HEAT LOAD TO EVCS":INPUT Q5(2)
420 PRINT "ENVIRONMENTAL HEAT LOAD TO PLSS":INPUT Q3(10)
```

TABLE II CONT.

```
430 PRINT "INC-FACTOR TO ALTER SUBLIMATOR UA (TYPICALLY=1)":INPU
T I
440 PRINT "DO YOU WISH TO HAVE A DIAGNOSTIC PRINTOUT? (INPUT O F
OR NO OR 1 FOR YES)":INPUT M
450 SELECT PRINT 215(132)
460 PRINT "SUITSK2 PROGRAM RUN":PRINT :PRINT
470 PRINT :PRINT "PROGRAM INPUT DATA:":PRINT
480 PRINT "QMETT,QENV,QFAN,QPUMP=";Q1(8);Q5(8);Q6(13);Q6(14)
490 PRINT "PTOT,PCO2,CFM,WH2O,UAST=";P1(2);P3(1);C5;W1(1);U1
500 PRINT "TWI,WCPW,CLIOH,CL2=";T4(8);W2(1);C1;C2
510 PRINT "CL3,CL4,RH=";C3;C4;H1
520 PRINT "TFI,TSUBO,XKEY,UAX,WLIOH,AP,UAW=";T1(13);T1(5);K;U2;W
1(19);A1;U3
530 PRINT "RFIN,HAGAS,CDP,UAHEL=";R1;U4;P4(1);U5
540 PRINT "TSKINT,QDCMEN,QDCMEL,QEVCS,QPLSEN,INC=";T3(1);Q1(9);Q
1(10);Q5(2);Q3(10);I
550 IF M=1 THEN 570
560 SELECT PRINT 005(64)
570 Q2(8)=1040*(.0655+.0252*Q1(8)/400)
580 T3(2)=T3(1)-.008125*Q1(8)
590 T4(6)=T3(2)-5
600 V2(8)=.0001625*Q1(8)
610 V3(8)=1.241*V2(8):K1=K
620 R1=R1*I
630 U4=U4*I
640 A1=A1*I
650 W1(2)=W1(1):W1(8)=W1(1)
660 T4(18)=0
670 Q3(18)=0
680 Q4(8)=0
690 Q1(28)=Q1(8)
700 W1(10)=0
710 Q1(2)=0
720 Q5(1)=0
730 K2=K1
740 Q1(2)=Q1(9)+Q1(10)
750 Q5(1)=Q5(2)+Q3(10)
760 Q2(7)=V3(8)*860
770 Q2(17)=V3(8)*430
780 Q3(8)=0
790 K3=0
800 S=C1+C2+C3
810 Q1(7)=Q2(17)+Q2(8)
820 B=U1/W1(1)
830 T1(1)=T1(13)+459.6
840 T1(4)=T1(5)
850 P2(4)=FN1(T1(4))
860 T1(4)=T1(4)+459.6
```

TABLE II CONT.

```
870 IF P2(4)<=P1(2)/2 THEN 890
880 P2(4)=P1(2)/2
890 PRINT :PRINT "TA4,PW4=";T1(4);P2(4):PRINT
900 D1=(P1(2)-P2(4))*2.981/T1(1)
910 V1(1)=D1*C5*60
920 V3(1)=P3(1)/(P1(2)-P2(4))*44/32*V1(1)
930 V2(4)=V1(1)-V3(1)
940 V4(4)=C5*60*P2(4)*144/85.7/T1(4)
950 V1(4)=V1(1)+V4(4)
960 FOR N=1 TO 50:PRINT :PRINT
970 PRINT "ITERATION CYCLE NUMBER";N:PRINT
980 Q3(9)=Q3(8)
990 N7=0
1000 Q1(7)=Q2(17)+Q2(8)+Q3(8)
1010 T3(2)=T3(1)-.008125*(Q1(8)-Q3(8))
1020 P2(6)=FN1(T3(2))
1030 P2(6)=P2(6)*H1
1040 V2(5)=V2(4)+V2(8)
1050 V1(5)=V2(5)+V4(4)+V3(1)
1060 A2=V4(4)/V2(5)
1070 R5=(V4(4)*85.7+V3(1)*35.1+V2(5)*48.3)/V1(5)
1080 P2(5)=P1(2)*V4(4)/V1(5)*85.7/R5
1090 PRINT "SUIT INLET CONDITIONS:"
1100 PRINT "PW5,R5,WT5,WW5,QSW=";P2(5);R5;V1(5);V4(4);Q3(8)
1110 V3(6)=V3(1)+V3(8)
1120 V2(6)=V2(5)-V2(8)
1130 IF Q1(8)>=749.99999 THEN 1680
1140 IF K3=1 THEN 1180
1150 V4(6)=V4(4)+Q2(8)/1040+Q3(8)/1040
1160 V1(6)=V4(6)+V2(6)+V3(6)
1170 GOTO 1400
1180 P2(16)=P2(6)
1190 FOR Z=1 TO 10
1200 V4(6)=V1(6)*P2(16)/P1(2)*R6/85.7
1210 V1(16)=V4(6)+V2(6)+V3(6)
1220 IF ABS(V1(16)-V1(6))<=V1(6)*.01 THEN 1240
1230 GOTO 1250
1240 IF Z>2 THEN 1310
1250 V1(6)=V1(16)
1260 R6=(V4(6)*85.7+V2(6)*48.3+V3(6)*35.1)/V1(6)
1270 NEXT Z
1280 PRINT "H2O FLOW SUIT OUT NOT CONVERGING"
1290 PRINT "WW6,PW6,WT6=";V4(6);P2(16);V1(6)
1300 STOP
1310 Q2(16)=1040*(V4(6)-V4(4))
1320 IF Q1(8)>=749.99999 THEN 1340
1330 GOTO 1350
1340 Q3(18)=Q3(8)-(Q2(16)-Q2(8))
```

TABLE II CONT.

```
1350 IF Q3(18)<0 THEN 1370
1360 GOTO 1380
1370 Q3(18)=0
1380 Q3(8)=Q2(16)-Q2(8)
1390 Q3(9)=Q3(8)
1400 Q3(6)=V1(6)*.22*(T3(2)-T1(4)+459.6)
1410 IF Q1(8)>=749.99999 THEN 1970
1420 REM LCG HEAT LOAD
1430 Q1(18)=Q1(8)-Q3(6)+Q5(8)-Q3(8)-Q2(8)
1440 REM AVERAGE GAS CONSTANT OUT OF SUIT
1450 R6=(V3(6)*35.1+V4(6)*85.7+V2(6)*48.3)/V1(6)
1460 REM SUIT OUTLET PARTIAL PRESSURE
1470 P3(6)=P1(2)*(V3(6)*35.1)/(V1(6)*R6)
1480 P2(16)=P1(2)*(V4(6)*85.7)/(V1(6)*R6)
1490 P4(6)=P2(6)/P2(16)-1
1500 IF P4(6)>.001 THEN 1520
1510 GOTO 1530
1520 IF Q3(8)<0 THEN 1560
1530 IF P2(16)>P2(6) THEN 1620
1540 PRINT "WW6,WT6,QSW PW6,PW6M=";V4(6);V1(6);Q3(8);P2(16);P2(6
)
1550 GOTO 1990
1560 V4(6)=V4(6)*P2(6)/P2(16)
1570 Q3(8)=(V4(6)-V4(4))*1040-Q2(8)
1580 Q1(7)=Q2(8)+Q2(17)+Q3(8)
1590 Q1(18)=Q1(8)-Q3(6)+Q5(8)-Q3(8)-Q2(8)
1600 PRINT "WW6,QSW,PP6=";V4(6);Q3(8);P4(6)
1610 GOTO 1160
1620 V4(6)=V4(6)*P2(6)/P2(16)-.001
1630 Q3(8)=(V4(6)-V4(4))*1040-Q2(8)
1640 Q1(7)=Q2(8)+Q2(17)+Q3(8)
1650 Q1(18)=Q1(8)-Q3(6)+Q5(8)-Q3(8)-Q2(8)
1660 PRINT "WW6,QSW=";V4(6);Q3(8)
1670 GOTO 1160
1680 IF N7>10 THEN 1970
1690 V4(6)=V4(4)+Q2(8)/1040+Q3(8)/1040
1700 V1(6)=V4(6)+V2(6)+V3(6)
1710 Q3(6)=V1(6)*.22*(T3(2)-T1(4)+459.6)
1720 REM DETERMINE QLCGMET FROM GRAPHICAL DATA
1730 IF Q1(8)<=1100 THEN 1750
1740 GOTO 1760
1750 Q1(17)=.65*Q1(8)+47.5
1760 IF Q1(8)>1100 THEN 1780
1770 GOTO 1790
1780 Q1(17)=.8438*Q1(8)-165.7
1790 REM DETERMINE TOTAL SWEATING RATE
1800 Q3(8)=Q1(8)-Q1(17)-Q3(6)-Q2(8)
1810 IF Q3(8)<0 THEN 1830
```

TABLE II CONT.

```
1820 GOTO 1840
1830 Q1(17)=Q1(17)+Q3(8)
1840 IF Q3(8)<0 THEN 1860
1850 GOTO 1870
1860 Q3(8)=0
1870 IF ABS(Q3(8)-Q3(9))<=.1 THEN 1910
1880 Q3(9)=Q3(8)
1890 GOTO 1680
1900 REM DETERMINE ACTIVE SWEATING AND INSENSIBLE SWEATING
1910 R6=(V3(6)*35.1+V4(6)*85.7+V2(6)*48.3)/V1(6)
1920 P2(16)=P1(2)*V4(6)*85.7/V1(6)/R6
1930 IF P2(16)<=P2(6) THEN 1970
1940 N7=N7+1
1950 PRINT "QSW,QSWA,PW6,PW6M,N7=";Q3(8);Q3(18);P2(16);P2(6);N7
1960 GOTO 1180
1970 Q1(18)=Q1(17)+Q5(8)
1980 P3(6)=P1(2)*V3(6)*35.1/V1(6)/R6
1990 T1(6)=T3(2)+459.6
2000 P2(15)=P1(2)*V4(6)*85.7/V1(6)/R6
2010 PRINT "WW6,WT6,QSW,PW6N,PW6M=";V4(6);V1(6);Q3(8);P2(15);P2(
6)
2020 REM LOOP ON LIOH OUTLET TEMPERATURE
2030 IF N=1 THEN 2050
2040 GOTO 2060
2050 T4(2)=T1(6)-469.6
2060 T3(3)=T4(2)+459.6
2070 V3(16)=V1(6)*.22
2080 Y(1,1)=C1+C4
2090 Y(2,1)=C4
2100 Y(3,1)=C1
2110 Y(4,1)=0
2120 Y(1,2)=-C4
2130 Y(2,2)=-C4-V3(16)
2140 Y(3,2)=0
2150 Y(4,2)=V3(16)
2160 Y(1,3)=-C1
2170 Y(2,3)=0
2180 Y(3,3)=-S
2190 Y(4,3)=C2
2200 Y(1,4)=0
2210 Y(2,4)=0
2220 Y(3,4)=C2
2230 Y(4,4)=-V3(16)-C2
2240 Z(1,1)=Q2(7)
2250 Z(2,1)=-V3(16)*T1(6)
2260 Z(3,1)=-C3*T3(3)
2270 Z(4,1)=0
2280 MAT I=INV(Y),M
```

TABLE II CONT.

```
2290 IF M=0 THEN 2310
2300 GOTO 2330
2310 PRINT "LIOH TEMPS NOT CONVERGING"
2320 STOP
2330 MAT X=I*Z
2340 T5(1)=X(1,1)
2350 T5(2)=X(2,1)
2360 T6(1)=X(3,1)
2370 T1(7)=X(4,1)
2380 PRINT "LIOH TEMPS CONVERGED"
2390 PRINT "QLS,WT6,TA7,TA6,TWPO=";Q2(7);V1(6);T1(7);T1(6);T4(2)
2400 PRINT "TLI,TLO,TC,TA7=";T5(1);T5(2);T6(1);T1(7)
2410 REM FAN INLET CONDITIONS
2420 V1(7)=V1(6)-V3(8)+Q2(17)/1060
2430 V3(7)=V3(6)-V3(8)
2440 IF V3(7)<0 THEN 2460
2450 GOTO 2470
2460 V3(7)=0
2470 V4(7)=V4(6)+Q2(17)/1060
2480 V2(7)=V2(6)
2490 R7=(V2(7)*48.3+V3(7)*35.1+V4(7)*85.7)/V1(7)
2500 P1(1)=P1(2)-P4(1)*(V1(7)↑1.30)/P1(2)*3.8/560*T1(7)
2510 D7=P1(1)*144/R7/T1(7)
2520 P3(7)=V3(7)/V1(7)*35.1/R7*P1(2)
2530 P2(7)=V4(7)/V1(7)*85.7/R7*P1(2)
2540 REM CALCULATED FAN FLOW RATE
2550 V1(17)=D7*C5*60
2560 PRINT "WC7,WW7,WO7,R7,PIN=";V3(7);V4(7);V2(7);R7;P1(1)
2570 PRINT "RHO7,PC7,PW7,WT7,WT7C=";D7;P3(7);P2(7);V1(7);V1(17)
2580 REM FAN OUTLET TEMP
2590 T1(2)=T1(7)+Q6(13)/(V1(17)*.22)
2600 REM LIOH SENS HEAT LOAD TO GAS
2610 Q3(19)=V1(6)*.22*(T1(7)-T1(6))
2620 REM TOTAL GAS HEAT LOAD SENS
2630 Q3(3)=Q3(19)+Q6(13)+Q3(6)
2640 IF Q3(3)<=0 THEN 2660
2650 GOTO 2670
2660 Q3(3)=Q3(19)+Q6(13)
2670 Q1(7)=Q2(8)+Q3(8)+Q2(17)
2680 Q1(3)=Q3(3)+Q1(7)
2690 REM WATER LOOP SUIT INLET TEMP
2700 T4(16)=T3(2)-Q1(18)/W1(1)/(1-EXP(-B))
2710 PRINT "TWSI,QLCG,PIN=";T4(16);Q1(18);P1(1)
2720 REM SUIT OUTLET TEMP-H2O
2730 T4(6)=T4(16)+Q1(18)/W1(1)
2740 T4(2)=T4(6)+(Q6(14)+Q5(1)+Q2(7)-Q3(19))/W1(1)
2750 T4(19)=T4(2)+(Q2(7)-Q3(19))/W1(19)
2760 REM TOTAL H2O LOOP HEAT LOAD
```

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TABLE II CONT.

```
2770 Q1(23)=Q1(18)+Q6(14)+Q2(7)-Q3(19)+Q5(1)+Q1(2)
2780 REM SUBLIMATOR WATER INLET TEMP
2790 T4(13)=T4(16)+Q1(23)/W1(1)
2800 PRINT "TWSI,TWSO,TWSBI,TWPO,QWT=";T4(16);T4(6);T4(13);T4(2)
;Q1(23)
2810 Q1(13)=Q1(23)+Q1(3)
2820 IF K2=2 THEN 4120
2830 REM TOTAL HEAT LOAD
2840 Q1(13)=Q1(23)+Q1(3)
2850 REM USING WATER LOOP COOLING
2860 W1(8)=W1(1)
2870 T2=0
2880 FOR N3=1 TO 10
2890 C=U2/W1(8)*(1-W1(8)/W2(1))
2900 E1=(1-EXP(-C))/(1-W1(8)/W2(1)*EXP(-C))
2910 T4(18)=T4(13)-E1*(T4(13)-T4(8))
2920 Q1(53)=W1(8)*(T4(13)-T4(18))
2930 PRINT "QT,QTC,TWXO,EFX,WHX=";Q1(13);Q1(53);T4(18);E1;W1(8)
2940 REM IS THE Q IN TOLERANCE?
2950 IF Q1(13)>Q1(53) THEN 3730
2960 IF Q1(13)>Q1(53) THEN 3080
2970 IF N3=1 THEN 2990
2980 GOTO 3000
2990 Q1(52)=Q1(53)
3000 IF (ABS(Q1(53)-Q1(13))-.01*Q1(13))<=0 THEN 3080
3010 W1(8)=W1(8)*Q1(13)/Q1(53)*.75+.25*W1(8)
3020 NEXT N3
3030 REM LOOP NOT CONVIRGED
3040 PRINT "HX LOOP NOT CONVG"
3050 PRINT "QT,QTC=";Q1(13);Q1(53)
3060 STOP
3070 REM CAN HX DO JOB?
3080 IF W1(8)>W1(1) THEN 3100
3090 GOTO 3130
3100 PRINT "HX NEEDS TOO MUCH FLOW"
3110 PRINT "WW,WHX=";W1(1);W1(8)
3120 STOP
3130 REM SUBLIMATOR PERFORMANCE- GAS TEMPS
3140 REM MASS FLOW RATIO
3150 W4=V1(17)*Q1(3)/Q3(3)/W1(8)*.22
3160 T2=(T4(13)+T4(18))/2
3170 IF T2>55 THEN 3220
3180 IF T2<=55 THEN 3200
3190 GOTO 3210
3200 IF T2>47.5 THEN 3270
3210 IF T2<=47.5 THEN 3320
3220 U3=(2.5785*W1(8)+124.01)*I
3230 IF W1(8)<144.63 THEN 3250
```

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TABLE II CONT.

```
3240 GOTO 3260
3250 U3=419.52*I
3260 GOTO 3370
3270 U3=(2.5*W1(8)+98)*I
3280 IF W1(8)<124.57 THEN 3300
3290 GOTO 3310
3300 U3=410.69*I
3310 GOTO 3370
3320 U3=(2.212*W1(8)+121.08)*I
3330 IF W1(8)<128 THEN 3350
3340 GOTO 3360
3350 U3=406*I
3360 GOTO 3370
3370 U9=U4*Q1(3)/Q3(3)*U3/(U4*Q1(3)/Q3(3)+U3)
3380 D=U9/(W4*W1(8))*(1-W4)
3390 E2=(1-EXP(-D))/(1-W4*EXP(-D))
3400 IF W4<=.125 THEN 3420
3410 GOTO 3430
3420 E2=.98*E2
3430 T1(22)=T4(18)+Q3(3)/V1(17)/.22/E2+459.6
3440 T1(24)=T1(22)-Q3(3)/V1(17)/.22
3450 PRINT "TAVG,UAW,WHX=";T2;U3;W1(8)
3460 PRINT "TWXO,TA2C,TA4C,EFSX,TA2=";T4(18);T1(22);T1(24);E2;T1
(2)
3470 PRINT "WR,QSSUB,D,C=";W4;Q3(3);D;C
3480 PRINT
3490 T4(14)=T4(18)+Q1(3)/W1(8)
3500 W1(12)=W1(1)-W1(8)
3510 IF W1(12)>0 THEN 3530
3520 GOTO 3540
3530 IF K3=1 THEN 3550
3540 GOTO 3680
3550 Q3(18)=0
3560 W1(8)=W1(1)
3570 W1(12)=0
3580 Q1(6)=Q1(8)
3590 Q1(8)=Q1(6)*Q1(52)/Q1(13)
3600 IF ABS(Q1(6)-Q1(8))>=5 THEN 3620
3610 GOTO 3630
3620 Q1(8)=Q1(6)+5
3630 IF Q1(8)>Q1(28) THEN 3650
3640 GOTO 3660
3650 Q1(8)=Q1(28)
3660 K3=0
3670 N=1
3680 Q1(33)=0
3690 Q1(23)=Q1(3)
3700 PRINT "QMTI,QMT=";Q1(6);Q1(8)
```

TABLE II CONT.

```
3710 REM GO TO CONVERGENCE CHECK
3720 GOTO 5340
3730 IF K3>0 THEN 4010
3740 REM FIRST ITERATION SET KEY
3750 IF N>3 THEN 3770
3760 GOTO 3790
3770 K3=1
3780 REM SUIT OUTLET H2O PRESS
3790 P2(16)=P2(6)*H1
3800 REM LOOP TO FIND H2O FLOW RATE
3810 FOR N4=1 TO 10
3820 V4(6)=P2(16)/P1(2)*V1(6)*R6/85.7
3830 V1(16)=V4(6)+V2(6)+V3(6)
3840 IF (ABS(V1(16)-V1(6))-.01*V1(6))<=0 THEN 3940
3850 REM NOT CONVG NEXT ITER.
3860 V1(6)=V1(16)
3870 R6=(V4(6)*85.7+V2(6)*48.3+V3(6)*35.1)/V1(6)
3880 NEXT N4
3890 REM LOOP NOT CONVG
3900 PRINT "H2O SUIT OUTLET NOT CONVG"
3910 PRINT "WW6,PW6,WT6=";V4(6);P2(16),V1(6)
3920 STOP
3930 REM SWEAT RATE
3940 Q2(16)=1040*(V4(6)-V4(4))
3950 Q3(8)=Q2(16)-Q2(8)
3960 IF Q3(8)<0 THEN 3980
3970 GOTO 3990
3980 Q3(8)=0
3990 GOTO 5420
4000 REM REDUCE METABOLIC HEAT LOAD
4010 Q1(8)=Q1(8)-5
4020 V2(8)=.0001625*Q1(8)
4030 Q2(8)=1040*(.0655+.0252*Q1(8)/400)
4040 T3(2)=T3(1)-.008125*Q1(8)
4050 V3(8)=1.241*V2(8)
4060 Q2(7)=V3(8)*860
4070 Q2(17)=V3(8)*430
4080 Q3(18)=0
4090 PRINT "QMT REDUCED:QMT,QML=";Q1(8);Q2(8)
4100 GOTO 5420
4110 REM LOOP ON SUBLIMATOR PERFORMANCE
4120 W1(8)=W1(1)
4130 REM LOOP ON FLOW RATE
4140 FOR L2=1 TO 20
4150 T3=0:N9=0:T2=0
4160 T4(3)=Q1(23)/W1(8)
4170 REM MASS FLOW
4180 W1(3)=(Q1(23)+Q1(3))/T4(3)
```

TABLE II CONT.

```
4190 REM Q/A PLATE
4200 Q1(43)=(Q1(23)+Q1(3))/A1
4210 G1=3.818E-07*Q1(43)+.001282
4220 U6=3.96*A1/G1
4230 REM SUBLIMATOR WATER UA
4240 U7=U3*U6/(U3+U6)
4250 N9=N9+1:IF N9=10 THEN 4600
4260 PRINT "TOLD,TAVG,NNN=";T3;T2;N9
4270 PRINT "UASW,UAW,UAG,WMCP=";U7;U3;U6;W1(3)
4280 PRINT "DTW,QAP,GAP=";T4(3);Q1(43);G1
4290 REM OUTLET TEMP
4300 T4(14)=32+(T4(13)-32)/EXP(U7/W1(3))
4310 IF T4(14)<33 THEN 4330
4320 GOTO 4340
4330 T4(14)=33
4340 IF ABS(T3-T4(14))<=.1 THEN 4600
4350 T3=T4(14):T2=(T4(13)+T4(14))/2
4360 IF T2<=75 THEN 4370:GOTO 4380
4370 IF T2>65 THEN 4430
4380 IF T2<=65 THEN 4390:GOTO 4400
4390 IF T2>55 THEN 4470
4400 IF T2<=55 THEN 4410:GOTO 4420
4410 IF T2>47.5 THEN 4510
4420 IF T2<=47.5 THEN 4550
4430 U3=(2.75*W1(8)+138)*I
4440 IF (U3-468*I)<0 THEN 4450:GOTO 4460
4450 U3=468*I
4460 GOTO 4240
4470 U3=(2.6*W1(8)+118)*I
4480 IF (U3-420*I)<0 THEN 4490:GOTO 4500
4490 U3=420*I
4500 GOTO 4240
4510 U3=(2.425*W1(8)+110)*I
4520 IF (U3-410*I)<0 THEN 4530:GOTO 4540
4530 U3=410*I
4540 GOTO 4240
4550 U3=(2.121*W1(8)+121.08)*I
4560 IF (U3-406*I)<0 THEN 4570:GOTO 4580
4570 U3=406*I
4580 GOTO 4240
4590 REM CALCULATED HEAT LOAD
4600 Q1(53)=W1(3)*(T4(13)-T4(14))
4610 IF L2=1 THEN 4620:GOTO 4630
4620 Q1(52)=Q1(53)
4630 REM IS Q WITHIN TOLERANCE ?
4640 PRINT "TWSIO,TWSBI,QTC,WHX=";T4(14);T4(13);Q1(53);W1(8)
4650 IF Q1(13)>Q1(53) THEN 4770
4660 IF Q1(13)>Q1(53) THEN 4680
```

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TABLE II CONT.

```
4670 GOTO 4690
4680 Q9=(Q1(13)-Q1(53))/4
4690 Q3(8)=Q3(8)+Q9
4700 Q9=0
4710 IF Q1(13)>Q1(53) THEN 4720:GOTO 4740
4720 IF N=3 THEN 4730:GOTO 4740
4730 K3=1
4740 IF Q1(13)>Q1(53) THEN 4910
4750 IF (ABS(Q1(53)-Q1(13))-.01*Q1(13))<=0 THEN 4910
4760 GOTO 4830
4770 IF L2>1 THEN 4910
4780 GOTO 4660
4790 IF N=1 THEN 4810
4800 GOTO 4740
4810 K3=1
4820 GOTO 4740
4830 REM NOT IN TOL- NEW VALUE OF W1(8)
4840 W1(8)=W1(8)*(Q1(13)/Q1(53))
4850 NEXT L2
4860 REM LOOP NOT CONVG- PRINT
4870 PRINT "HX LOOP NOT CONVG"
4880 PRINT "QT,QTC=";Q1(13);Q1(53)
4890 STOP
4900 REM IF FLOW TOO HIGH
4910 IF W1(8)>W1(1) THEN 4930
4920 GOTO 4960
4930 PRINT "HX NEEDS TOO MUCH FLOW"
4940 PRINT "WW,WHX=";W1(1);W1(8)
4950 STOP
4960 W1(12)=W1(1)-W1(8)
4970 IF W1(12)>0 THEN 4980:GOTO 4990
4980 IF K3=1 THEN 5000
4990 GOTO 5050
5000 Q9=0:Q3(18)=0:W1(8)=W1(1):W1(12)=0:Q1(6)=Q1(8)
5010 Q1(8)=Q1(6)*Q1(52)/Q1(13)
5020 IF ABS(Q1(6)-Q1(6)*Q1(52)/Q1(13))>=5 THEN 5030:GOTO 5040
5030 Q1(8)=Q1(6)+5
5040 N=1
5050 W1(10)=Q1(13)/1027:Q1(33)=Q1(13)
5060 PRINT "WBYPS,WFEED,QTSBL,QMT,QMTI=";W1(12);W1(10);Q1(33);Q1
(8);Q1(6)
5070 REM AIRSIDE OF SUBLIMATOR - WALL TEMP - PRIMARY
5080 T4(29)=32+(T4(13)-T4(14))/LOG((T4(13)-32)/(T4(14)-32))
5090 REM METAL TEMP
5100 T6(2)=32+Q1(13)/U6+Q1(13)/R1+3.63-1.587E-03*Q1(13)
5110 T1(14)=T1(4)
5120 R=LOG(10*P2(7)):T2(7)=FN2(R)+459.6
5130 U1(4)=U4*Q1(3)/Q3(3)
```

TABLE II CONT.

```
5140 FOR N5=1 TO 10
5150 W3(1)=Q1(7)/(T2(7)-T1(14))
5160 T1(24)=T6(2)+Q1(7)/W3(1)/(EXP(U1(4)/W3(1))-1)+459.6
5170 PRINT "TA4A,TA4C=";T1(14);T1(24)
5180 IF ABS(T1(14)-T1(24))<=.1 THEN 5260
5190 REM GAS OUTLET TEMP
5200 T1(14)=T1(24)
5210 NEXT N5
5220 PRINT "SUBL GAS TEMP NOT CONVG"
5230 PRINT "TD7,WM,TA4C,TM,TWL=";T2(7);W3(1);T1(24);T6(2);T4(29)
5240 STOP
5250 REM GAS INLET TEMP
5260 T1(22)=T1(24)+Q3(3)/(V1(17)*.22)
5270 PRINT "TA2C,TA2=";T1(22);T1(2)
5280 PRINT "TD7,WM,TA4C,TM,TWL=";T2(7);W3(1);T1(24);T6(2);T4(29)
5290 T4(18)=T4(13)
5300 IF Q1(13)>Q1(53) THEN 5320
5310 GOTO 5330
5320 IF K3=1 THEN 4010
5330 REM IS THIS THE FIRST ITERATION ?
5340 IF N<=4 THEN 5420
5350 Q2(3)=(V4(7)-V4(4))*1040
5360 PRINT "QLC,QLT=";Q2(3);Q1(7)
5370 REM NO- IS SYSTEM CONVERGED ?
5380 IF (ABS(T1(24)-T1(4))-.2)>0 THEN 5420
5390 T3(12)=T3(1)-.008125*(Q1(8)-Q3(8))
5400 IF (ABS(T3(12)-T3(2))-1)<=0 THEN 5640
5410 REM NOT CONVERGED, NEW ITERATION SET UP
5420 V1(1)=V1(17)-V4(7)+V4(4)
5430 T1(4)=T1(24)*.5+.5*T1(4)
5440 IF T1(4)<491.6 THEN 5450:GOTO 5460
5450 T1(4)=491.6
5460 T1(1)=T1(7)
5470 REM DEW POINT LEAVING HX
5480 P2(4)=FN1(T1(4)-459.6)
5490 IF P2(4)>P1(2)/2 THEN 5510
5500 GOTO 5520
5510 P2(4)=P1(2)/2
5520 REM H2O VAPOR LEAVING HX
5530 R4=(V2(7)*48.3+V3(7)*35.1+V4(4)*85.7)/V1(1)
5540 V4(4)=V1(1)*P2(4)/P1(2)*R4/85.7
5550 REM CO2 LEAVING HX
5560 V3(1)=P3(1)/P1(2)*V1(1)*R4/35.1
5570 V2(4)=V1(1)-V4(4)-V3(1)
5580 PRINT "WG1,TA4,TA1,PPW4,R4=";V1(1);T1(4);T1(1);P2(4);R4
5590 PRINT "WW4,WC1,WO1=";V4(4);V3(1);V2(4)
5600 NEXT N
```

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TABLE II CONCLUDED

```
5610 REM TEMP LOOP NOT CONVERGED - PRINT
5620 PRINT "LOOP NOT CONVERGED"
5630 STOP
5640 PRINT "LOOPS CONVERGED. LOAD SECOND PROGRAM, SUITOUT, BY PU
TTING THE   APPROPRIATE TAPE CARTRIDGE INTO THE TAPE DRIVE AND P
RESSING THE CONTINUE/RETURN KEYS."
5650 PRINT
5660 REM GO TO "SUITOUT" FOR DATA OUTPUT
5670 STOP
5680 LOAD "SUITOUT"
```

TABLE III

SUITSK2 AND SUITOUT BASIC TO FORTRAN

VARIABLE CROSS REFERENCE

BASIC	FORTRAN	BASIC	FORTRAN
A1	AP	P2(7)	PW7
A2	AHS1	P2(15)	PW6N
B	B	P2(16)	PW6
C	C	P3(1)	PC1
C1	CL1	P3(2)	PC2
C2	CL2	P3(6)	PC6
C3	CL3	P3(7)	PC7
C4	CL4	P4(1)	CDP
C5	CFM	P4(6)	PP6
C6	CP6	Q6	QMETTW
D	D	Q8	QLATST
D1	RHO1	Q9	DQSW
D7	RHO7	Q1(2)	QDCM
E1	EFX	Q1(3)	QSTOT
E2	EFSX	Q1(6)	QMTI
G1	GAP	Q1(7)	QLT
H1	RH	Q1(8)	QMT
I	INC	Q1(9)	QDCMEN
K	RKEY	Q1(10)	QDCMEL
K1	XKEY	Q1(13)	QT
K2	IKEY	Q1(17)	QLCGM
K3	KEY	Q1(18)	QLCG
N9	NNN	Q1(23)	QWT
P1(1)	PIN	Q1(28)	QMTO
P1(2)	PT	Q1(33)	QTSBL
P2(4)	PW4	Q1(43)	QAP
P2(5)	PW5	Q1(52)	QTCI
P2(6)	PW6M	Q1(53)	QTC

TABLE III CONT.

BASIC	FORTRAN	BASIC	FORTRAN
Q2(3)	QLC	T1(6)	TA6
Q2(7)	QLS	T1(7)	TA7
Q2(8)	QML	T1(13)	TF1
Q2(16)	QLMAX	T1(14)	TA4A
Q2(17)	QLL	T1(22)	TA2C
Q2(18)	QLSTW	T1(24)	TA4C
Q3(3)	QSSUB	T2(5)	TD5
Q3(6)	QS6	T2(6)	TD6
Q3(8)	QSW	T2(7)	TD7
Q3(9)	QSWO	T3(1)	TSKINT
Q3(10)	QPLSEN	T3(2)	TSK
Q3(18)	QSWA	T3(3)	TSO
Q3(19)	QLSG	T3(12)	TSKC
Q4(8)	QSTR	T4(2)	TWPO
Q5(1)	QEV2	T4(3)	DTW
Q5(2)	QEVCS	T4(6)	TWSO
Q5(8)	QENV	T4(8)	TWI
Q6(13)	QFAN	T4(13)	TWSBI
Q6(14)	QP	T4(14)	TWSBO
R1	RFIN	T4(16)	TWSI
R4	R4	T4(18)	TWXO
R5	R5	T4(19)	TWLO
R6	R6	T4(29)	TWL
R7	R7	T5(1)	TLI
S	SU	T5(2)	TLO
T1	THEL	T6(1)	TC
T2	TAVG	T6(2)	TM
T3	TOLD	U1	UAST
T1(1)	TAI	U2	UAX
T1(2)	TA2	U3	UAW
T1(4)	TA4	U4	UAGAS
T1(5)	TSTI	U5	UAHEL

TABLE III CONCLUDED

BASIC	FORTRAN	BASIC	FORTRAN
U6	UAG	W1(2)	WS
U7	UASW	W1(3)	WMCP
U8	UASC	W1(8)	WHX
U9	UASX	W1(10)	WFEED
U1(4)	UAGS	W1(12)	WBYPS
V1	VO2A	W1(19)	WLIOH
V2	VSLURP	W2(1)	WCPW
V4	V4	W3(1)	WM
V5	V5		
V1(1)	WG1		
V1(4)	WT4		
V1(5)	WT5		
V1(6)	WT6		
V1(7)	WT7		
V1(16)	WT6C		
V1(17)	WT7C		
V2(4)	WO1		
V2(5)	WO5		
V2(6)	WO6		
V2(7)	WO7		
V2(8)	WO2A		
V3(1)	WC1		
V3(6)	WC6		
V3(7)	WC7		
V3(8)	WCO2		
V3(16)	WCP		
V4(4)	WW4		
V4(6)	WW6		
V4(7)	WW7		
W4	WR		
W5	WSEP		
W1(1)	WW		

SUITOUT COMPUTER PROGRAM

File Name "SUITOUT"

Abstract "SUITOUT" provides the printout for the data calculated in the "SUITSK2" program. Figures 2 and 3 show tabularized data output and the flowchart data format provided by the program. This program is the second half of the Hamilton Standard "SUITSK2" program which has been converted from Fortran to Basic for use on the Wang 2200/Flatbed plotter system.

Program Description

The program is automatically loaded by the "SUITSK2" program. The user is required only to load the program tape cartridge into the tape drive unit as instructed by the "SUITSK2" program. The program provides data output for the variables calculated in the "SUITSK2" program by printing the tabularized output as exemplified in Figure 2. Table IV identifies the output data definitions and units. In addition, an optional flowchart is provided as shown in Figure 3. If the user desires the flowchart, the CRT instructs him to load a blank flowchart (Figure 4) onto the flatbed plotter. The plotter then plots the data onto the blank flowchart. Both of the examples of output data shown in Figures 2 and 3 are the result of the input data shown in Figure 1.

Because the Wang 2200 system does not automatically round off numbers, a routine is included in the program which performs that function. Therefore, the data provided in both the tabularized format and the flowchart are rounded off values. Also, a special function, DEFFN2, is included in the program to calculate a saturation temperature in degrees F based upon the log of 10 times the saturation pressure in psia. The function is based upon a subroutine "KANDK" used by the original Fortran version of the program. A listing of program "SUITOUT" is provided in Table V with a cross reference between the original Fortran variable names and the Basic variable names provided in Table III.

FIGURE 2 SUITOUT PROGRAM EXAMPLE

TABULARIZED OUTPUT

```
PROGRAM OUTPUT DATA:

SUIT CONDITIONS:

WTOTI,WH2OI,WCO2I,PH2OI,PCO2I,TGASI,TDPI= 31.67   .24
 3.00000000E-02   .1995   .5002   53.2   53.1
WTOTO,WH2OO,WCO2O,PH2OO,PCO2O,TGASO,TDPO= 31.83   .36   .23
 .3063   4.0894   87.1   65.1
THEL,TSKIN,TLCGI,TLCGO= 55.1   87.125   74.85   78.25
WSUIT,WO2,VO2,WCO2,VSI= 185   .163   3.06000000E-02   .2016625
 6.01
QMANS,QMANRL,QSW,QMANTL,QLCG,QLCGT= 237.4   133.64   0   133.6
 628.9   628.9

LIOH CONDITIONS:

WTOTO,WH2OO,WCO2O,PH2OO,PCO2O,TGASO,TDPO= 31.71   .45
 3.00000000E-02   .3752   .4944   95.9   71
TLIOH,TGO,TCASE,TH2OI,TH2OO,PTOTO= 101.5   99.8   87.4   79.9
 85.2   15.0798
QLS,QLL,QLSG,QLH2O= 173.4   86.7   61.2   112.2

SUBLIMATOR CONDITIONS:

WSUBL,WBYPS,WFEED,WSEP,VSLURP,VSUBO= 42.54   142.46   0   .2103
 7.00000000E-02   5.97
TGASI,TH2OI,TH2OO,TVHXI,TVHXO= 97.4   80.01   57.46   45   45
QSUBL,QSUBS,QSUBVT,QWTOT,QTSUB,QVHXT= 220.4   309.7   530   530   0
 1484.1

REVISED PROGRAM INPUT DATA:

QMETT,QENV,QFAN,QPUMP= 1000   0   11   145
PTOT,PCO2,CFM,WH2O,UAST= 15.2   9.67000000E-03   6.6   185   60
TWI,WCPW,CLIOH,CL2= 45   600   6   3.2
CL3,CL4,RH= 15   50   .9
TFI,TSUBO,XKEY,UAX,WLIOH,AP,UAW= 115   50   1   864.6   21   .2361
 419.52
RFIN,HAGAS,CDP,UAHEL= 471.6   16.28   5.42000000E-03   .4
TSKINT,QDCMEN,QDCMEL,QEVCS,QPLSEN,INC= 95.25   0   27   41   0   1
```

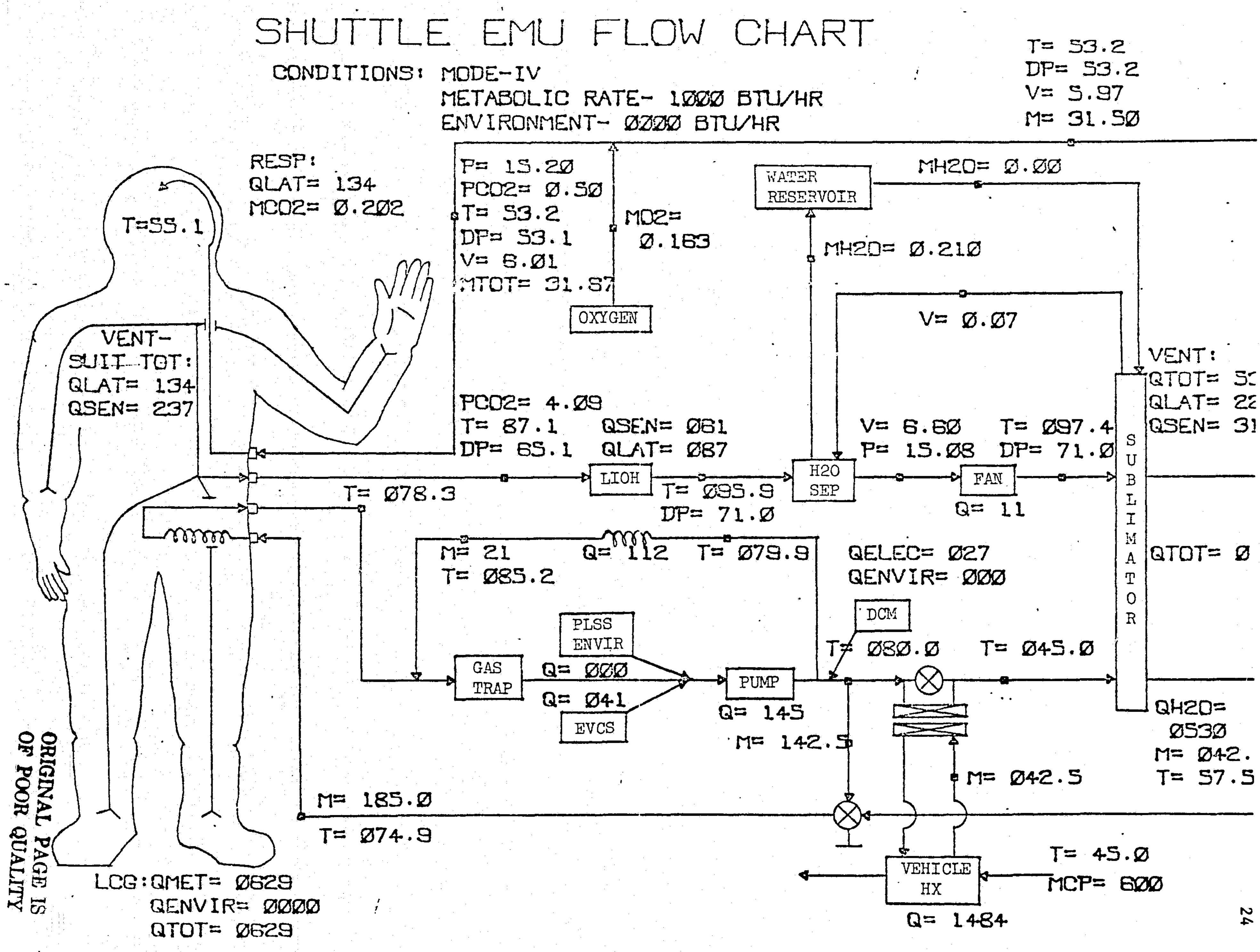

FIGURE 3 SUITOUT PROGRAM EXAMPLE FLOWCHART OUTPUT

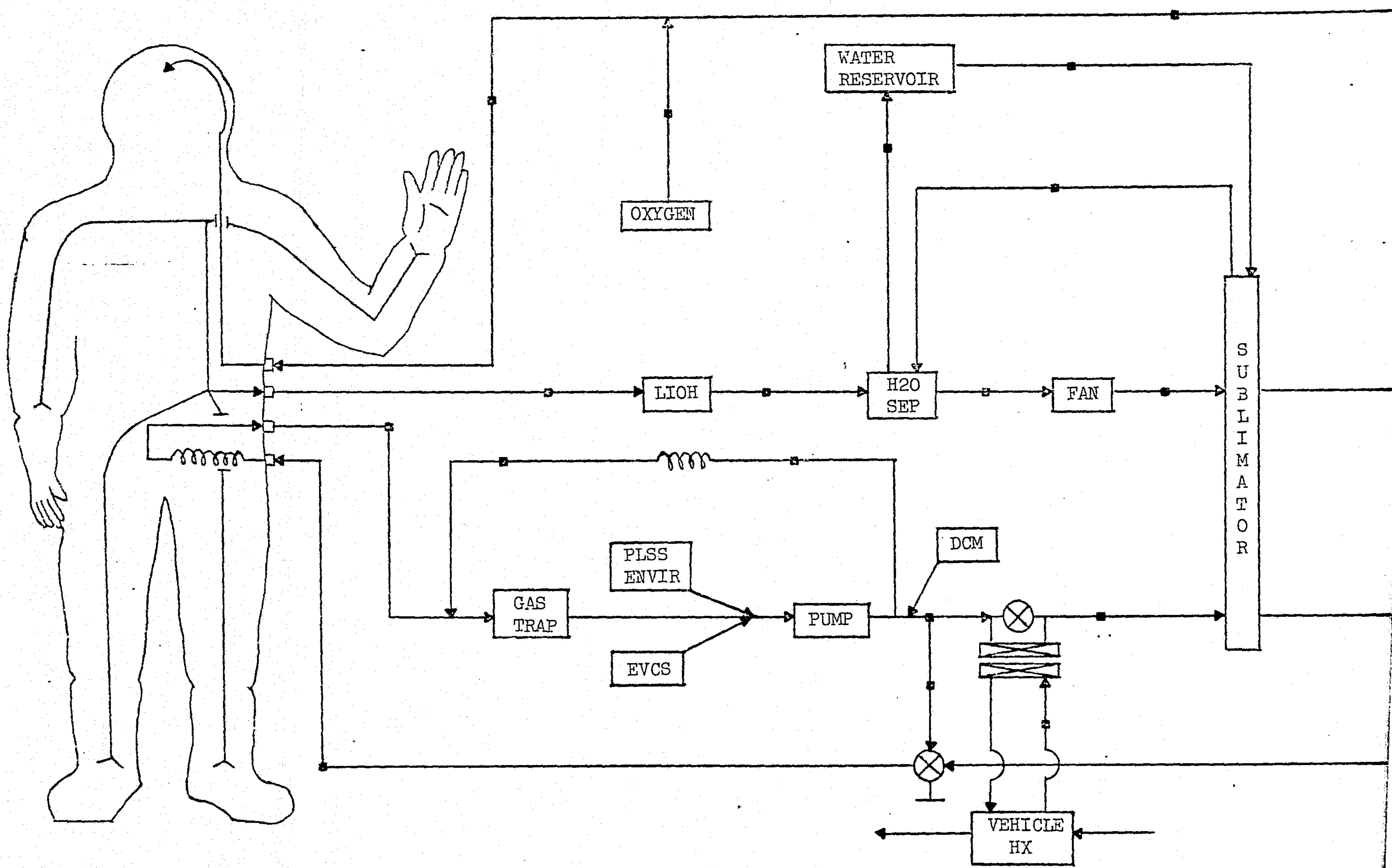

FIGURE 4 BLANK FLOWCHART FOR SUITOUT PROGRAM

TABLE IV SUITOUT OUTPUT DATA DESCRIPTION

NAME	DESCRIPTION	UNIT
WTOTI	TOTAL GAS FLOW RATE AT INLET	LB/HR
WH2OI	WATER VAPOR FLOW RATE AT INLET	LB/HR
WCO2I	CO2 FLOW RATE AT INLET	LB/HR
PH2OI	PARTIAL PRESSURE OF H2O AT INLET	MMHG
PCO2I	PARTIAL PRESSURE OF CO2 AT INLET	MMHG
TGASI	GAS TEMPERATURE AT INLET	^oF
TDPI	DEW POINT TEMPERATURE AT INLET	^oF
WTOTO	TOTAL GAS FLOW RATE AT OUTLET	LB/HR
WH2OO	WATER VAPOR FLOW RATE AT OUTLET	LB/HR
WCO2O	CO2 FLOW RATE AT OUTLET	LB/HR
PH2OO	PARTIAL PRESSURE OF H2O AT OUTLET	MMHG
PCO2O	PARTIAL PRESSURE OF CO2 AT OUTLET	MMHG
TGASO	GAS TEMPERATURE AT OUTLET	^oF
TDPO	DEW POINT TEMPERATURE AT OUTLET	^oF
THEL	GAS TEMPERATURE INSIDE HELMET	^oF
TSKIN	SKIN TEMPERATURE	^oF
TLCGI	LCG COOLANT TEMPERATURE AT INLET	^oF
TLCGO	LCG COOLANT TEMPERATURE AT OUTLET	^oF
WSUIT	LCG COOLANT FLOW RATE	LB/HR
WO2	O2 ADDITION/CONSUMPTION BY MAN	LB/HR
VO2	O2 ADDITION/CONSUMPTION BY MAN	CFM
WCO2	CO2 PRODUCTION RATE BY MAN	LB/HR
VSI	GAS VOLUMETRIC FLOW RATE AT SUIT INLET	CFM
QMANS	SENSIBLE HEAT GENERATED BY MAN	BTU/HR
QMANLR	RESPIRATORY LATENT HEAT GENERATED BY MAN	BTU/HR
QSW	LATENT HEAT GENERATED BY SWEATING	BTU/HR
QMANTL	TOTAL LATENT HEAT GENERATED BY MAN	BTU/HR
QLCG	HEAT LOAD FROM MAN TO LCG	BTU/HR
QLCGT	HEAT LOAD FROM MAN PLUS SUIT ENVIRONMENTAL TO LCG	BTU/HR
TLIOH	LIOH BED TEMPERATURE	^oF
TGO	GAS TEMPERATURE INSIDE LIOH CANISTER	^oF
TCASE	LIOH CANISTER WALL TEMPERATURE	^oF
TH2OI	H2O COOLANT TEMPERATURE AT INLET	^oF
TH2OO	H2O COOLANT TEMPERATURE AT OUTLET	^oF
PTOTO	TOTAL GAS PRESSURE AT LIOH OUTLET/FAN INLET	PSIA
QLS	SENSIBLE HEAT GENERATED BY LIOH	BTU/HR
QLL	LATENT HEAT GENERATED BY LIOH	BTU/HR
QLSG	LIOH SENSIBLE HEAT ABSORBED BY GAS LOOP	BTU/HR
QLH2O LIOH	LIOH SENSIBLE HEAT ABSORBED BY H2O COOLANT LOOP	BTU/HR
WSUBL	H2O FLOW RATE THROUGH SUBLIMATOR	LB/HR
WBYPS	H2O FLOW RATE BYPASSING SUBLIMATOR	LB/HR
WFEED	FEEDWATER FLOW RATE	LB/HR
WSEP	H2O SEPARATED BY WATER SEPARATOR	LB/HR
VSLURP	SLURPER VOLUMETRIC FLOW RATE	CFM
VSUBO	GAS VOLUMETRIC FLOW RATE AT SUBLIMATOR OUTLET	CFM
TVHXI	H2O COOLANT TEMPERATURE AT VEHICLE HX INLET	^oF
TVHXO	H2O COOLANT TEMPERATURE AT VEHICLE HX OUTLET	^oF
QSUBL	LATENT HEAT REMOVED FROM SUBLIMATOR VENT LOOP	BTU/HR
QSUBS	SENSIBLE HEAT REMOVED FROM SUBLIMATOR VENT LOOP	BTU/HR
QSUBT	TOTAL HEAT REMOVED FROM SUBLIMATOR VENT LOOP	BTU/HR
QWTOT	HEAT LOAD REMOVED FROM SUBLIMATOR H2O LOOP	BTU/HR
QTSUB	TOTAL HEAT LOAD REMOVED FROM SUBLIMATOR THROUGH SUBLIMATION	BTU/HR
QUHXT	HEAT LOAD REMOVED BY VEHICLE HX	BTU/HR

TABLE V SUITOUT PROGRAM LISTING

```
10 REM "SUITOUT"-PRINTOUT FOR SUITSK2 PROGRAM WITH PLOT CAPABILI
TY
20 COM Q1(53),Q2(18),Q3(19),Q4(8),Q5(8),Q6(14),U1(4),P1(2),P2(16
),P3(7),P4(6),R4
30 COM W1(19),W2(1),W3(1),T1(24),T2(7),T3(12),T4(29),T5(2),T6(2)
,V1(17),V2(8),V3(16),V4(7)
40 DEFFN2(X)=35.15789+24.592588*X+2.1182069*X↑2-.3414474*X↑3+.15
741642*X↑4-.031329585*X↑5+.0038658282*X↑6-.00024901784*X↑7+.0000
068401559*X↑8
50 P3(2)=P3(1)*51.73
60 P3(6)=P3(6)*51.73
70 V5=V1(5)*R5*T1(4)/P1(2)/144/60
80 V4=V1(1)*R4*T1(4)/P1(2)/144/60
90 V1=V2(8)*48.3*T1(4)/P1(2)/144/60
100 T1(4)=T1(4)-459.6
110 T1=T3(2)-((T3(2)-T1(4))/EXP(U5/(V1(5)*.22)))
120 T1(6)=T1(6)-459.6
130 T1(7)=T1(7)-459.6
140 T1(2)=T1(2)-459.6
150 T5(1)=T5(1)-459.6
160 T5(2)=T5(2)-459.6
170 T6(1)=T6(1)-459.6
180 V2=.0105*C5
190 Q8=Q2(8)+Q3(8)
200 Q6=Q1(8)-Q8-Q3(6)-Q3(18)
210 P3(7)=P3(7)*51.73
220 Q2(18)=Q2(7)-Q3(19)
230 R=LOG(10*P2(16)):T2(6)=FN2(R)
240 R=LOG(10*P2(5)):T2(5)=FN2(R)
250 T2(7)=T2(7)-459.6
260 W5=V4(7)-V4(4)
270 R=LOG(10*P2(7)):T2(7)=FN2(R)
280 IF K=1 THEN 290:Q1(13)=0
290 GOTO 580
300 SELECT PRINT 215(132)
310 PRINT :PRINT
320 PRINT "PROGRAM OUTPUT DATA:":PRINT
330 PRINT "SUIT CONDITIONS:":PRINT
340 PRINT "WTOTI,WH2OI,WCO2I,PH2OI,PCO2I,TGASI,TDPI=";V1(5);V4(4
);V3(1);P2(5);P3(2);T1(4);T2(5)
350 PRINT "WTOTO,WH2OO,WCO2O,PH2OO,PCO2O,TGASO,TDPO=";V1(6);V4(6
);V3(6);P2(16);P3(6);T1(6);T2(6)
360 PRINT "THEL,TSKIN,TLCGI,TLCGO=";T1;T3(2);T4(16);T4(6)
370 PRINT "WSUIT,WO2,VO2,WCO2,VSI=";W1(2);V2(8);V1;V3(8);V5
380 PRINT "QMANS,QMANRL,QSW,QMANTL,QLCG,QLCGT=";Q3(6);Q2(8);Q3(8
);Q8;Q6;Q1(18)
390 PRINT :PRINT "LIOH CONDITIONS:":PRINT
400 PRINT "WTOTO,WH2OO,WCO2O,PH2OO,PCO2O,TGASO,TDPO=";V1(7);V4(7
```

TABLE V CONT.

```
);V3(7);P2(7);P3(7);T1(7);T2(7)
410 PRINT "TLIOH,TGO,TCASE,TH2OI,TH2OO,PTOTO=";T5(1);T5(2);T6(1)
;T4(2);T4(19);P1(1)
420 PRINT "QLS,QLL,QLSG,QLH2O=";Q2(7);Q2(17);Q3(19);Q2(18)
430 PRINT :PRINT "SUBLIMATOR CONDITIONS:":PRINT
440 PRINT "WSUBL,WBYPS,WFEED,WSEP,VSLURP,VSUBO=";W1(8);W1(12);W1
(10);W5;V2;V4
450 PRINT "TGASI,TH2OI,TH2OO,TVHXI,TVHXO=";T1(2);T4(13);T4(14);T
4(8);T4(18)
460 PRINT "QSUBL,QSUBS,QSUBVT,QWTOT,QTSUB,QVHXT=";Q1(7);Q3(3);Q1
(3);Q1(23);Q1(33);Q1(13)
470 PRINT :PRINT "REVISED PROGRAM INPUT DATA:":PRINT
480 PRINT "QMETT,QENV,QFAN,QPUMP=";Q1(8);Q5(8);Q6(13);Q6(14)
490 PRINT "PTOT,PCO2,CFM,WH2O,UAST=";P1(2);P3(1);C5;W1(1);U1
500 PRINT "TWI,WCPW,CLIOH,CL2=";T4(8);W2(1);C1;C2
510 PRINT "CL3,CL4,RH=";C3;C4;H1
520 PRINT "TFI,TSUBO,XKEY,UAX,WLIOH,AP,UAW=";T1(13);T1(5);K;U2;W
1(19);A1;U3
530 PRINT "RFIN,HAGAS,CDP,UAHEL=";R1;U4;P4(1);U5
540 PRINT "TSKINT,QDCMEN,QDCMEL,QEVCS,QPLSEN,INC=";T3(1);Q1(9);Q
1(10);Q5(2);Q3(10);I
550 SELECT PRINT 005(64):INPUT "DO YOU WISH TO PLOT CHART (0=NO,
1=YES)", L
560 IF L=0 THEN 570:GOTO 1180
570 END
580 N=V1(5):GOSUB 2370:V1(5)=N4
590 N=V4(4):GOSUB 2370:V4(4)=N4
600 N=V3(1):GOSUB 2370:V3(1)=N4
610 N=P3(2):GOSUB 2450:P3(2)=N4
620 N=P2(5):GOSUB 2450:P2(5)=N4
630 N=T1(4):GOSUB 2330:T1(4)=N4
640 N=T1:GOSUB 2330:T1=N4
650 N=V1(6):GOSUB 2370:V1(6)=N4
660 N=V4(6):GOSUB 2370:V4(6)=N4
670 N=V3(6):GOSUB 2370:V3(6)=N4
680 N=P3(6):GOSUB 2450:P3(6)=N4
690 N=P2(16):GOSUB 2450:P2(16)=N4
700 N=T1(6):GOSUB 2330:T1(6)=N4
710 N=V1(7):GOSUB 2370:V1(7)=N4
720 N=V4(7):GOSUB 2370:V4(7)=N4
730 N=V3(7):GOSUB 2370:V3(7)=N4
740 N=P3(7):GOSUB 2450:P3(7)=N4
750 N=P2(7):GOSUB 2450:P2(7)=N4
760 N=T1(7):GOSUB 2330:T1(7)=N4
770 N=T1(2):GOSUB 2330:T1(2)=N4
780 N=T5(1):GOSUB 2330:T5(1)=N4
790 N=T5(2):GOSUB 2330:T5(2)=N4
800 N=T6(1):GOSUB 2330:T6(1)=N4
```

TABLE V CONT.

```
810 N=T4(19):GOSUB 2330:T4(19)=N4
820 N=T4(16):GOSUB 2370:T4(16)=N4
830 N=T4(6):GOSUB 2370:T4(6)=N4
840 N=T4(13):GOSUB 2370:T4(13)=N4
850 N=W1(8):GOSUB 2370:W1(8)=N4
860 N=T4(18):GOSUB 2370:T4(18)=N4
870 N=T4(14):GOSUB 2370:T4(14)=N4
880 N=W1(2):GOSUB 2370:W1(2)=N4
890 N=Q1(7):GOSUB 2330:Q1(7)=N4
900 N=Q3(3):GOSUB 2330:Q3(3)=N4
910 N=Q1(3):GOSUB 2330:Q1(3)=N4
920 N=Q1(23):GOSUB 2330:Q1(23)=N4
930 N=Q1(18):GOSUB 2330:Q1(18)=N4
940 N=Q3(6):GOSUB 2330:Q3(6)=N4
950 N=Q2(7):GOSUB 2330:Q2(7)=N4
960 N=Q3(19):GOSUB 2330:Q3(19)=N4
970 N=Q2(17):GOSUB 2330:Q2(17)=N4
980 N=Q3(8):GOSUB 2330:Q3(8)=N4
990 N=Q2(18):GOSUB 2330:Q2(18)=N4
1000 N=V5:GOSUB 2370:V5=N4
1010 N=V4:GOSUB 2370:V4=N4
1020 N=V1:GOSUB 2450:V1=N4
1030 N=T2(5):GOSUB 2330:T2(5)=N4
1040 N=T2(6):GOSUB 2330:T2(6)=N4
1050 N=T2(7):GOSUB 2330:T2(7)=N4
1060 N=V2(8):GOSUB 2410:V2(8)=N4
1070 N=W5:GOSUB 2450:W5=N4
1080 N=T4(2):GOSUB 2330:T4(2)=N4
1090 N=Q8:GOSUB 2330:Q8=N4
1100 N=Q6:GOSUB 2330:Q6=N4
1110 N=Q1(33):GOSUB 2330:Q1(33)=N4
1120 N=Q1(13):GOSUB 2330:Q1(13)=N4
1130 N=W1(12):GOSUB 2370:W1(12)=N4
1140 N=V2:GOSUB 2370:V2=N4
1150 N=W1(10):GOSUB 2410:W1(10)=N4
1160 N=P1(1):GOSUB 2450:P1(1)=N4
1170 GOTO 300
1180 N=P3(2):GOSUB 2370:P3(2)=N4
1190 N=P3(6):GOSUB 2370:P3(6)=N4
1200 N=T4(16):GOSUB 2330:T4(16)=N4
1210 N=T4(6):GOSUB 2330:T4(6)=N4
1220 N=T4(18):GOSUB 2330:T4(18)=N4
1230 N=W1(8):GOSUB 2330:W1(8)=N4
1240 N=T4(13):GOSUB 2330:T4(13)=N4
1250 N=T4(14):GOSUB 2330:T4(14)=N4
1260 N=W1(2):GOSUB 2330:W1(2)=N4
1270 N=Q1(7):GOSUB 2290:Q1(7)=N4
1280 N=Q3(3):GOSUB 2290:Q3(3)=N4
```

TABLE V CONT.

```
1290 N=Q1(3):GOSUB 2290:Q1(3)=N4
1300 N=Q1(23):GOSUB 2290:Q1(23)=N4
1310 N=Q1(18):GOSUB 2290:Q1(18)=N4
1320 N=Q3(6):GOSUB 2290:Q3(6)=N4
1330 N=Q2(7):GOSUB 2290:Q2(7)=N4
1340 N=Q3(19):GOSUB 2290:Q3(19)=N4
1350 N=Q2(17):GOSUB 2290:Q2(17)=N4
1360 N=Q3(8):GOSUB 2290:Q3(8)=N4
1370 N=Q2(18):GOSUB 2290:Q2(18)=N4
1380 N=W5:GOSUB 2410:W5=N4
1390 N=Q8:GOSUB 2290:Q8=N4
1400 N=Q6:GOSUB 2290:Q6=N4
1410 N=Q1(33):GOSUB 2290:Q1(33)=N4
1420 N=Q1(13):GOSUB 2290:Q1(13)=N4
1430 N=W1(12):GOSUB 2330:W1(12)=N4
1440 N=P1(1):GOSUB 2370:P1(1)=N4
1450 N=V3(8):GOSUB 2410:V3(8)=N4
1460 N=Q2(8):GOSUB 2290:Q2(8)=N4
1470 PRINT :PRINT :PRINT "IS PLOTTER POWER ON?":PRINT "IS PLOT P
APER LOADED?":PRINT "IS CHART SWITCH ON HOLD?":PRINT "IS PEN IN
DOWN POSITION AND CAP OFF?"
1480 PRINT "ARE SCALE LIMITS SET (0,0 BY 10,10)?":INPUT "IS ANSW
ER TO ALL ABOVE QUESTIONS YES? (0=NO,1=YES)",L:IF L<>1 THEN 1470
1490 GOTO 1500
1500 REM PLOT ROUTINE FOR SUITSKR
1510 SELECT PLOT 414:SELECT PRINT 414
1520 PLOT <2,,C>,<24,,S>
1530 PLOT <230,775,U>:PRINT "SHUTTLE EMU FLOW CHART":PLOT <,,R>
1540 PLOT <1,,C>,<12,,S>
1550 PLOT <240,738,U>:PRINT "CONDITIONS: MODE-":IF K=1 THEN 1560
:PRINT "EV":PLOT <-84,-20,U>:GOTO 1570
1560 PRINT "IV":PLOT <-84,-20,U>
1570 CONVERT Q1(8) TO Z1$,(-####):PRINT "METABOLIC RATE-";Z1$:PL
OT <12,,U>:PRINT "BTU/HR":PLOT <-325,-20,U>
1580 CONVERT Q5(8)+Q3(10)+Q1(9) TO Z2$,(-####):PRINT "ENVIRONMEN
T-";Z2$:PLOT <12,,U>:PRINT "BTU/HR":PLOT <,,R>
1590 PLOT <400,660,U>:CONVERT P1(2) TO A1$,(-##.##):PRINT "P=";A
1$:PLOT <-96,-20,U>
1600 CONVERT P3(2) TO A2$,(-#.##):PRINT "PCO2=";A2$:PLOT <-120,-
20,U>
1610 CONVERT T1(4) TO A3$,(-##.#):PRINT "T=";A3$:PLOT <-84,-20,U
>
1620 CONVERT T2(5) TO A4$,(-##.#):PRINT "DP=";A4$:PLOT <-96,-20,
U>
1630 CONVERT V5 TO A5$,(-#.##):PRINT "V=";A5$:PLOT <-84,-20,U>
1640 CONVERT V1(5) TO A6$,(-##.##):PRINT "MTOT=";A6$:PLOT <,,R>
1650 PLOT <400,460,U>:CONVERT P3(6) TO B1$,(-#.##):PRINT "PCO2="
;B1$:PLOT <-120,-20,U>
```

TABLE V CONT.

```
1660 CONVERT T1(6) TO B2$,(-##.#):PRINT "T=";B2$:PLOT <-84,-20,U
>
1670 CONVERT T2(6) TO B3$,(-##.#):PRINT "DP=";B3$:PLOT <,,R>
1680 PLOT <520,440,U>:CONVERT Q3(19) TO C1$,(-###):PRINT "QSEN="
;C1$:PLOT <-108,-20,U>
1690 CONVERT Q2(17) TO C2$,(-###):PRINT "QLAT=";C2$:PLOT <,,R>
1700 PLOT <570,385,U>:CONVERT T1(7) TO D1$,(-###.#):PRINT "T=";D
1$:PLOT <-96,-20,U>
1710 CONVERT T2(7) TO D2$,(-##.#):PRINT "DP=";D2$:PLOT <,,R>
1720 PLOT <740,440,U>:CONVERT C5 TO E1$,(-#.##):PRINT "V=";E1$:P
LOT <-84,-20,U>
1730 CONVERT P1(1) TO E2$,(-##.##):PRINT "P=";E2$:PLOT <,,R>
1740 PLOT <820,370,U>:CONVERT Q6(13) TO F1$,(-##):PRINT "Q=";F1$
:PLOT <,,R>
1750 PLOT <857,440,U>:CONVERT T1(2) TO G1$,(-###.#):PRINT "T=";G
1$:PLOT <-96,-20,U>
1760 CONVERT T2(7) TO G2$,(-##.#):PRINT "DP=";G2$:PLOT <,,R>
1770 PLOT <983,500,U>:PRINT "VENT:":PLOT <-60,-20,U>
1780 CONVERT Q1(3) TO H1$,(-###):PRINT "QTOT=";H1$:PLOT <-108,-2
0,U>
1790 CONVERT Q1(7) TO H2$,(-###):PRINT "QLAT=";H2$:PLOT <-108,-2
0,U>
1800 CONVERT Q3(3) TO H3$,(-###):PRINT "QSEN=";H3$:PLOT <,,R>
1810 PLOT <790,530,U>:CONVERT V2 TO I1$,(-#.##):PRINT "V=";I1$:P
LOT <,,R>
1820 PLOT <790,660,U>:CONVERT W1(10) TO J1$,(-#.##):PRINT "MH2O=
";J1$:PLOT <,,R>
1830 PLOT <710,590,U>:CONVERT W5 TO K1$,(-#.###):PRINT "MH2O=";K
1$:PLOT <,,R>
1840 PLOT <880,760,U>:CONVERT T1(4) TO L1$,(-##.#):PRINT "T=";L1
$:PLOT <-84,-20,U>
1850 PRINT "DP=";L1$:PLOT <-96,-20,U>
1860 CONVERT V4 TO L2$,(-#.##):PRINT "V=";L2$:PLOT <-84,-20,U>
1870 CONVERT V1(5)-V2(8) TO L3$,(-##.##):PRINT "M=";L3$:PLOT <,,
R>
1880 PLOT <540,615,U>:CONVERT V2(8) TO M1$,(-#.###):PRINT "MO2="
:PLOT <-48,-20,U>:PRINT M1$:PLOT <,,R>
1890 PLOT <300,380,U>:CONVERT T4(6) TO N1$,(-###.#):PRINT "T=";N
1$:PLOT <,,R>
1900 PLOT <470,231,U>:CONVERT Q3(10) TO O1$,(-###):PRINT "Q=";O1
$:PLOT <-72,-25,U>
1910 CONVERT Q5(2) TO O2$,(-###):PRINT "Q=";O2$:PLOT <,,R>
1920 PLOT <620,196,U>:CONVERT Q6(14) TO P1$,(-###):PRINT "Q=";P1
$:PLOT <,,R>
1930 PLOT <600,330,U>:CONVERT T4(2) TO Q1$,(-###.#):PRINT "T=";Q
1$:PLOT <-192,,U>
1940 CONVERT Q2(18) TO R1$,(-###):PRINT "Q=";R1$:PLOT <-192,,U>
1950 CONVERT W1(19) TO S1$,(-##):PRINT "M=";S1$:PLOT <-60,-20,U>
```

TABLE V CONT.

```
1960 CONVERT T4(19) TO S2$,(-###.#):PRINT "T=";S2$:PLOT <,,R>
1970 PLOT <710,250,U>:CONVERT T4(13) TO T1$,(-###.#):PRINT "T=";
T1$:PLOT <,,R>
1980 PLOT <730,330,U>:CONVERT Q1(10) TO U1$,(-###):PRINT "QELEC=
";U1$:PLOT <-120,-20,U>
1990 CONVERT Q1(9) TO U2$,(-###):PRINT "QENVIR=";U2$:PLOT <,,R>
2000 PLOT <840,250,U>:CONVERT T4(18) TO U3$,(-###.#):PRINT "T=";
U3$:PLOT <,,R>
2010 PLOT <984,330,U>:IF K=1 THEN 2020:CONVERT Q1(33) TO U4$,(-#
###):PRINT "QTOT=";U4$:PLOT <,,R>:GOTO 2030
2020 CONVERT V TO U4$,(-#):PRINT "QTOT=";U4$:PLOT <,,R>
2030 PLOT <988,200,U>:CONVERT Q1(23) TO U5$,(-####):PRINT "QH2O=
":PLOT <-60,-20,U>:PRINT U5$:PLOT <-60,-20,U>
2040 CONVERT W1(8) TO U6$,(-###.#):PRINT "M=";U6$:PLOT <-96,-20,
U>
2050 CONVERT T4(14) TO U7$,(-##.#):PRINT "T=";U7$:PLOT <,,R>
2060 PLOT <830,140,U>:IF K=1 THEN 2070:CONVERT V TO V1$,(-#.#):P
RINT "M=";V1$:PLOT <,,R>:GOTO 2080
2070 CONVERT W1(8) TO V1$,(-###.#):PRINT "M=";V1$:PLOT <,,R>
2080 PLOT <630,170,U>:CONVERT W1(12) TO V2$,(-###.#):PRINT "M=";
V2$:PLOT <,,R>
2090 PLOT <898,75,U>:IF K=1 THEN 2100:CONVERT V TO V3$,(-#.#):PR
INT "T=";V3$:PLOT <-72,-25,U>:GOTO 2110
2100 CONVERT T4(8) TO V3$,(-##.#):PRINT "T=";V3$:PLOT <-84,-25,U
>:GOTO 2120
2110 CONVERT V TO V4$,(-#):PRINT "MCP=";V4$:PLOT <,,R>:GOTO 2130
2120 CONVERT W2(1) TO V4$,(-###):PRINT "MCP=";V4$:PLOT <,,R>
2130 PLOT <780,20,U>:IF K=1 THEN 2140:CONVERT V TO V5$,(-#):PRIN
T "Q=";V5$:PLOT <,,R>:GOTO 2150
2140 CONVERT Q1(13) TO V5$,(-####):PRINT "Q=";V5$:PLOT <,,R>
2150 PLOT <280,120,U>:CONVERT W1(2) TO V6$,(-###.#):PRINT "M=";V
6$:PLOT <-96,-30,U>
2160 CONVERT T4(16) TO V7$,(-###.#):PRINT "T=";V7$:PLOT <,,R>
2170 PLOT <110,605,U>:CONVERT T1 TO W1$,(-##.#):PRINT "T=":PLOT
<-12,,U>:PRINT W1$:PLOT <,,R>
2180 PLOT <220,660,U>:PRINT "RESP:":PLOT <-60,-20,U>
2190 CONVERT Q2(8) TO W2$,(-###):PRINT "QLAT=";W2$:PLOT <-108,-2
0,U>
2200 CONVERT V3(8) TO W3$,(-#.###):PRINT "MCO2=";W3$:PLOT <,,R>
2210 PLOT <94,510,U>:PRINT "VENT-":PLOT <-88,-20,U>
2220 PRINT "SUIT TOT:":PLOT <-108,-20,U>
2230 CONVERT Q8 TO W4$,(-###):PRINT "QLAT=";W4$:PLOT <-108,-20,U
>
2240 CONVERT Q3(6) TO W5$,(-###):PRINT "QSEN=";W5$:PLOT <,,R>
2250 PLOT <90,50,U>:PRINT "LCG:":CONVERT Q6 TO W6$,(-####):PRINT
"QMET=";W6$:PLOT <-120,-20,U>
2260 CONVERT Q5(8) TO W7$,(-####):PRINT "QENVIR=";W7$:PLOT <-144
,-20,U>
```

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TABLE V CONCLUDED

```
2270 CONVERT Q1(18) TO W8$,(-####):PRINT "QTOT=";W8$:PLOT <,,R>
2280 STOP
2290 N3=INT(N)
2300 D=N-N3:IF D>=.5 THEN 2310:GOTO 2320
2310 N4=N3+1:RETURN
2320 N4=N3:RETURN
2330 N1=N*10:N2=INT(N1):N3=N2/10
2340 D=N-N3:IF D>=.05 THEN 2350:GOTO 2360
2350 N4=N3+.1:RETURN
2360 N4=N3:RETURN
2370 N1=N*100:N2=INT(N1):N3=N2/100
2380 D=N-N3:IF D>=.005 THEN 2390:GOTO 2400
2390 N4=N3+.01:RETURN
2400 N4=N3:RETURN
2410 N1=N*1000:N2=INT(N1):N3=N2/1000
2420 D=N-N3:IF D>=.0005 THEN 2430:GOTO 2440
2430 N4=N3+.001:RETURN
2440 N4=N3:RETURN
2450 N1=N*10000:N2=INT(N1):N3=N2/10000
2460 D=N-N3:IF D>=.00005 THEN 2470:GOTO 2480
2470 N4=N3+.0001:RETURN
2480 N4=N3:RETURN
```

LIOHPPC COMPUTER PROGRAM

File Name "LIOHPPC"

Abstract "LIOHPPC" plots the partial pressure of CO2 at the upper and lower LIOH canister outlets and at the ARS inlet. The program also provides an optional printout of the plotted data. Figures 5 and 6 provide examples of the plot and its corresponding data printout. The program is designed for use with the Wang 2200 series computer system.

Program Description

The program supplies detail instructions on the CRT while it is being run. Initially, the user chooses between a plot of the data and a printout of the data. If plots are required, the user is asked whether the data will be keyed in or if it has been previously stored on tape. If it has been previously stored on tapes, the program will instruct the user to load the appropriate tape and file number and the data will be loaded. If the data is to be keyed in, the CRT will ask for the date of the test, the type of case (3.75 man case, 7.25 man case, etc.), and the value of x at the origin. The program then requests the test data points. The user inputs the time in minutes, the partial pressure of CO_2 at the ARS inlet in mmHg, the partial pressure of CO_2 at the upper canister outlet in mmHg, and the partial pressure of CO_2 at the lower canister outlet in mmHg. A total of 150 sets of data points can be keyed in by the user. Before the data is stored onto tape, the program allows corrections to be made to the data. This can be accomplished by inserting line numbers 261 through 269 into the program with revised data and executing these line numbers. The program then instructs the user to place a data tape into the tape drive 10B, asks which file number is to be used, and saves the data.

Next, the program asks whether plots are to be made. If the user answers no, the program is ended. But if plots are desired, the CRT asks whether a 900 minute or 1800 minute time range is desired. This option allows the user to choose between a 900 or an 1800 minute time range along the x axis. This was necessary because some of the cases had longer times between canister changeouts than other cases. When all of the required plot parameters are defined, the program utilizes the generalized plot routine as a subroutine to produce the plots.

Next the program instructs the user to load the graph paper onto the flatbed plotter and then produces the graph exemplified by the 7 man case shown in Figure 5. The label on the plot is optional and if desired, the user must position the label where it will not interfere with the graph.

If initially a printout of the results was desired instead of plots, the user is instructed to load the appropriate data tape onto the tape drive unit 10A and specify which file is to be printed out. The program then supplies the print out as exemplified by the 7 man case shown in Figure 6. A listing of the program "LIOHPPC" is provided in Table VI. The data used to generate the plots has been saved and retained on tapes for possible further analysis. A discussion of the RSECS LiOH test results based upon the plots provided by this program can be found in Memorandum EC2-77-185 dated 11-8-77.

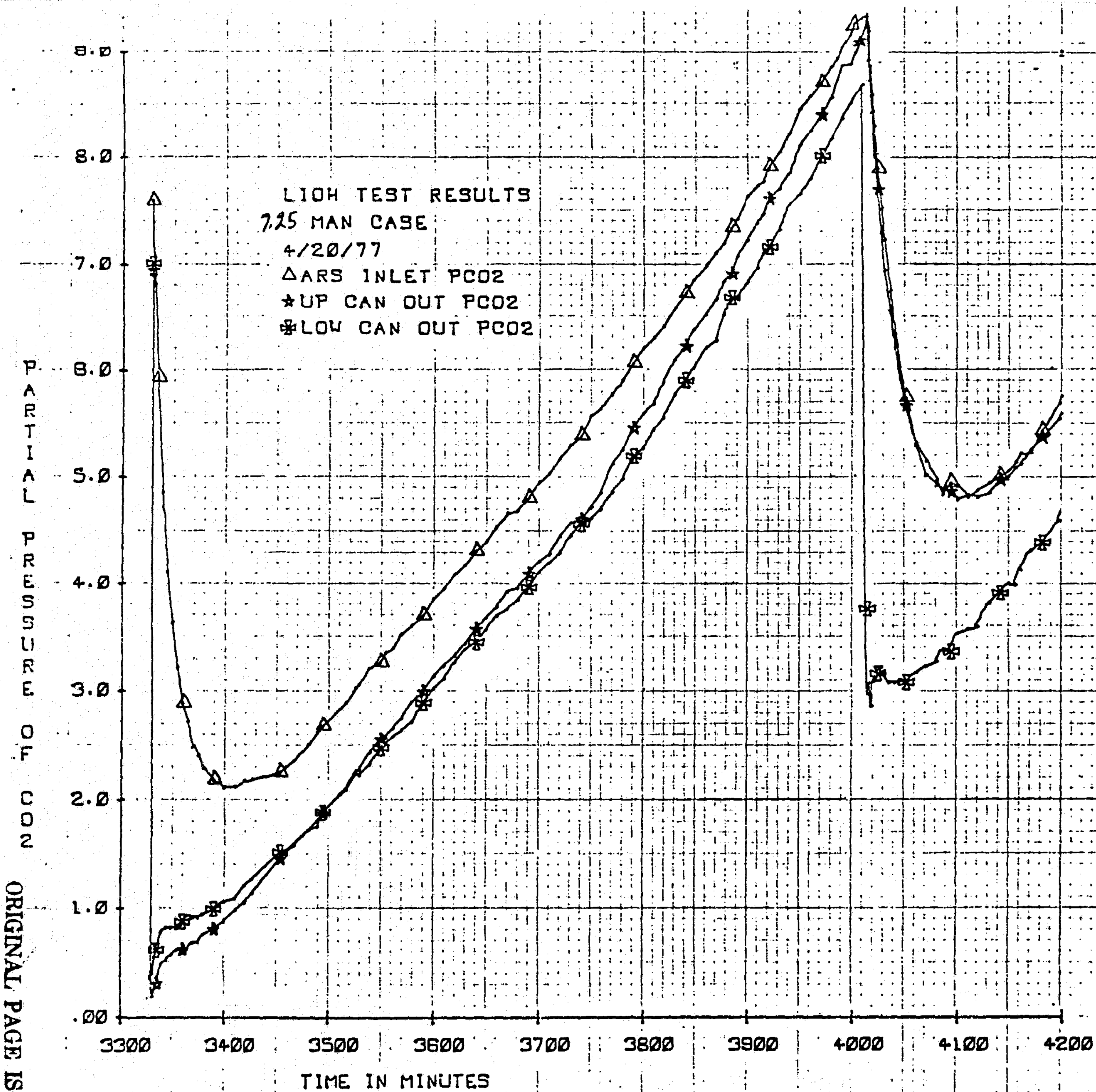

FIGURE 5 LIOHPPC PROGRAM EXAMPLE PLOT

FIGURE 6 LIOHPPC PROGRAM EXAMPLE DATA TABULATION

RSECS PPCO2 DATA:FILE NUMBER 1

TEST DATE=4/20/77
TYPE OF CASE=7 MAN CASE
VALUE OF X AT THE ORIGIN= 3300
TOTAL NUMBER OF DATA POINTS= 108

I	TIME Q(I)	ARSIN H(I)	UPCAN P(I)	LOWCAN Q1(I)
1	3329	7.57	6.92	6.98
2	3330	7.38	6.87	.33
3	3331	7.07	.21	.39
4	3332	6.79	.17	.37
5	3335	5.92	.28	.58
6	3340	4.84	.46	.75
7	3345	4.1	.5	.79
8	3350	3.61	.55	.79
9	3355	3.2	.59	.78
10	3360	2.87	.59	.84
11	3365	2.7	.6	.9
12	3370	2.47	.66	.88
13	3375	2.39	.66	.88
14	3380	2.27	.73	.91
15	3390	2.16	.78	.96
16	3400	2.09	.85	1.03
17	3411	2.1	.96	1.06
18	3420	2.15	1.03	1.18
19	3428	2.17	1.12	1.24
20	3454	2.23	1.43	1.48
21	3460	2.28	1.49	1.48
22	3468	2.34	1.57	1.54
23	3482	2.49	1.7	1.69
24	3490	2.6	1.78	1.72
25	3495	2.66	1.85	1.85
26	3518	2.88	2.09	2.06
27	3527	3.01	2.24	2.2
28	3530	3.04	2.25	2.19
29	3540	3.19	2.41	2.29
30	3550	3.24	2.53	2.44
31	3555	3.33	2.57	2.49
32	3562	3.37	2.64	2.55
33	3570	3.5	2.73	2.61
34	3580	3.58	2.88	2.69
35	3590	3.67	2.97	2.86
36	3600	3.83	3.11	2.99
37	3610	3.93	3.21	3.08
38	3620	4.07	3.3	3.23
39	3630	4.16	3.41	3.35

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FIGURE 6 CONT.

40	3640	4.29	3.54	3.41
41	3650	4.38	3.65	3.53
42	3660	4.52	3.75	3.66
43	3670	4.64	3.9	3.72
44	3680	4.67	3.94	3.81
45	3690	4.78	4.07	3.93
46	3700	4.93	4.19	4.08
47	3710	5.01	4.26	4.17
48	3720	5.15	4.42	4.26
49	3730	5.27	4.55	4.42
50	3740	5.36	4.58	4.53
51	3750	5.55	4.7	4.59
52	3759	5.62	4.83	4.67
53	3770	5.76	5.1	4.83
54	3780	5.89	5.23	4.95
55	3790	6.04	5.43	5.16
56	3800	6.18	5.57	5.24
57	3810	6.28	5.67	5.41
58	3819	6.39	5.87	5.52
59	3830	6.56	6.07	5.74
60	3840	6.7	6.19	5.87
61	3848	6.84	6.35	5.99
62	3860	6.97	6.5	6.17
63	3870	7.1	6.65	6.24
64	3877	7.18	6.82	6.49
65	3884	7.32	6.89	6.65
66	3890	7.4	7.06	6.66
67	3900	7.61	7.21	6.81
68	3909	7.71	7.36	6.94
69	3915	7.75	7.44	7.08
70	3920	7.89	7.58	7.13
71	3930	8.03	7.68	7.29
72	3940	8.21	7.83	7.53
73	3950	8.43	8.1	7.62
74	3960	8.55	8.23	7.77
75	3970	8.67	8.37	7.98
76	3980	8.84	8.53	8.15
77	3990	9.04	8.84	8.33
78	3998	9.17	8.86	8.47
79	4009	9.28	9.11	8.64
80	4013	9.36	9.38	3.72
81	4015	9.06	8.9	2.94
82	4016	8.84	8.7	3.04
83	4018	8.55	8.4	2.83
84	4020	8.27	8.05	3.05
85	4023	7.87	7.67	3.12
86	4027	7.5	7.27	3.18

FIGURE 6 CONCLUDED

87	4030	7.21	6.92	3.12
88	4035	6.73	6.55	3.04
89	4040	6.31	6.19	3.04
90	4050	5.72	5.64	3.04
91	4060	5.3	5.28	3.13
92	4070	5.13	4.99	3.19
93	4080	4.96	4.9	3.23
94	4086	4.82	4.86	3.34
95	4093	4.93	4.84	3.32
96	4100	4.9	4.77	3.49
97	4110	4.8	4.81	3.53
98	4119	4.86	4.79	3.55
99	4130	4.93	4.83	3.77
100	4140	4.99	4.95	3.87
101	4148	5.04	4.98	3.97
102	4155	5.12	5.06	3.95
103	4160	5.2	5.1	4.1
104	4170	5.21	5.23	4.28
105	4180	5.41	5.34	4.35
106	4197	5.67	5.52	4.56
107	4200	5.75	5.58	4.66
108	4210	5.83	5.74	4.74

TABLE VI LIOHPPC PROGRAM LISTING

```
10 REM LIOHPPC-PROGRAM EITHER PRINTS OUT TEST DATA OR PLOTS
      PARTIAL PRESSURES OF CO2 VERSUS TIME FOR LIOH TEST DATA
20  COM X9(150).Y9(150),C(10),X$25,Y$25,P$1,C$30,D$20
30 COM E$20,F$20,Z1,G$,H$,I$,J$
40 COM Q(150),H(150),P(150),D(10),Q1(150)
50 E$="LIOH TEST RESULTS"
60 G$="ARS INLET PCO2"
70 H$="UP CAN OUT PCO2"
80 I$="LOW CAN OUT PCO2"
90 PRINT "INPUT TYPE OF RUN DESIRED":PRINT " 1=LOAD DATA FROM TA
PE AND OBTAIN PRINTOUT OF DESIRED FILES"
100 PRINT " 2=LOAD DATA (TAPE OR KEY IN) AND OBTAIN PLOTS"
110 INPUT Q:IF Q=2 THEN 120:GOTO 1960
120 INPUT "IS DATA TO BE LOADED FROM TAPE (0=NO , 1=YES)",Q:
    IF Q=0 THEN 150
130 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE L
OADED",N1 :SELECT TAPE 10B:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
    NEXT K:IF N1=1 THEN 140:N=N1-1:SKIP NF
140 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
                IF END THEN 300:GOTO 300
150 INPUT "DATE OF TEST (MTH/DAY/YR)",D$
160 INPUT "TYPE OF CASE",J$
170 INPUT "VALUE OF X AT THE ORIGIN",Z1
180 PRINT :PRINT "INPUT TEST DATA (STOP BY ENTERING NEGATIVE VAL
UES)":PRINT
190 I=1
200 PRINT "DATA POINT       TIME, ARS, UP CAN, LOW CAN   "
210 PRINT "    ";I,;:INPUT Q(I),H(I),P(I),Q1(I)
220 IF Q(I)>-.0000001 THEN 230:I=I-1:D(8)=I:GOTO 250
230 I=I+1
240 GOTO 210
250 PRINT "ARE THERE ANY DATA CORRECTIONS TO BE MADE?"
260 STOP
270 PRINT "LOAD DATA TAPE ON UNIT 10B":PRINT
280 INPUT "FILE NUMBER WHERE DATA IS TO SAVED",N1:
    SELECT TAPE 10B:REWIND :P9=0:FOR K=1 TO 50:P9=P9+1:NEXT K:
    IF N1=1 THEN 290:N=N1-1:SKIP NF
290 SELECT TAPE 10B:DATA SAVE OPEN "LTEST":DATA SAVE D$,J$,Z1,D(
8),Q(),H(),P(),Q1():DATA SAVE END :SELECT TAPE 10A
300 SELECT TAPE 10A:INPUT "DO YOU WISH TO PLOT DATA (0=NO,1=YES)
"    ,Q9:IF Q9=0 THEN 500
310 PRINT "DO YOU WISH TO HAVE A 900 OR 1800 MINUTE TIME RANGE?"

320 PRINT " 1=900 MINUTE TIME RANGE":PRINT " 2=1800 MINUTE TIME
RANGE"
330 INPUT Q:IF Q=2 THEN 350
340 K6=D(8):X0=100:Y0=1:X1=1:Y1=1:C1=Z1:C2=0:S1=Z1:S2=Z1+900:T1=
0:T2=9:X$="TIME IN MINUTES":Y$="PARTIAL PRESSURE OF CO2":L1=2:L2
```

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TABLE VI CONT.

```
=1:GOSUB '00:GOTO 360
350 K6=D(8):X0=200:Y0=2:X1=1:Y1=1:C1=Z1:C2=0:S1=Z1:S2=Z1+1800:T1
=0:T2=12:X$="TIME IN MINUTES":Y$="PARTIAL PRESSURE OF CO2":L1=2:
L2=1:GOSUB '00
360 FOR R=1 TO 3
370 IF R=3 THEN 450
380 IF R=2 THEN 420
390 FOR I=1 TO K6:X9(I)=Q(I):Y9(I)=H(I):NEXT I
400 P$=HEX(00):D=1:K=1:K5=K6:L8=1:L9=K6:GOSUB '03
410 GOTO 470
420 FOR I=1 TO K6:X9(I)=Q(I):Y9(I)=P(I):NEXT I
430 P$=HEX(01):D=1:K=1:K5=K6:L8=1:L9=K6:GOSUB '03
440 GOTO 470
450 FOR I=1 TO K6:X9(I)=Q(I):Y9(I)=Q1(I):NEXT I
460 P$=HEX(02):D=1:K=1:K5=K6:L8=1:L9=K6:GOSUB '03
470 NEXT R
480 INPUT "DO YOU WISH TO LABEL GRAPH? (0=NO, 1=YES)",P:IF P=0 T
HEN 500
490 GOSUB '04:GOSUB 1890
500 STOP
510 DEFFN' 00:Q=0:GOSUB 520:PLOT <,,R>:RETURN
520 SELECT PRINT 005: PRINT HEX(03):PRINT :PRINT :
    PRINT "*** GENERATING PLOTS OF ";E$;" ***"
530 PRINT :PRINT :PRINT " IS PLOTTER POWER ON ?":PRINT " IS PLOT
 PAPER LOADED ? ":PRINT " IS CHART SWITCH ON HOLD ? ":PRINT " IS
 PEN IN DOWN POSITION AND CAP OFF ?"
540 PRINT " ARE SCALE LIMITS SET (0,0 BY 10,10) ?"
550 INPUT " IS ANSWER TO ALL ABOVE QUESTIONS YES ? (YES=1,NO=0)"
,Q:      IF Q<>1 THEN 520
560 SELECT PLOT 414:PLOT <1,,C>,<12,,S>:Q=0
570 F1=100/X0:F2=100/Y0:GOSUB 800:PLOT <1,,C>,<,,S>
580 RETURN
590 DEFFN'03:SELECT PRINT 005:PRINT HEX(03):
     PLOT <,,R>,<100*X1,100*Y1,U>,<1,,C>
600 X4,Y4,E,E3,E4,E6,E8,E7=0:X$=" ":U1=1
610 K=1:X4,Y4=0
620 K1=K:W=1
630 U2=0:X=X9(K):IF X>S2 THEN 680:Y=Y9(K):IF Y>9 THEN 680:GOSUB
'125:IF U2=1 THEN 700:X=X9(K)-C1:Y=Y9(K)-C2:X4,Y4=0
640 IF K>K1 THEN 660:PLOT <,,R>,<100*X1,100*Y1,U>,<F1*X,F2*Y,U>
650 PLOT <,,D>,<,,P$>:GOSUB 1720:GOTO 670
660 GOSUB '122(X,Y,X4,Y4)
670 PLOT <-X*F1,-Y*F2,U>:GOTO 700
680 IF K/5=W THEN 690:GOTO 700
690 W=W+1
700 K=K+1:IF K>=K5+1 THEN 710:GOTO 630
710 X4,Y4,E,E3,E4,E6,E8,E7=0:U1=2:PLOT <,,R>,<100*X1,100*Y1,U>
720 FOR I=L8 TO L9
```

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TABLE VI CONT.

```
730 X=X9(I)-C1:Y=Y9(I)-C2
740 IF X>900 THEN 770:IF Y>9 THEN 770
750 IF I<>L8 THEN 760:U1=1:GOSUB '122(X,Y,X4,Y4):U1=2:GOTO 780
760 GOSUB '122(X,Y,X4,Y4):GOTO 780
770 U3=1
780 NEXT I
790 PLOT <,,U>:PLOT <,,R>:RETURN
800 A1=F1*ABS(S1-C1):A2=F1*ABS(S2-C1):B1=F2*ABS(T1-C2):B2=F2*ABS
(T2-C2)
810 PLOT <,,R>,<100*X1,100*Y1,U>,<-A1,0,U>,<A1+A2,0,D>,<-A2,-B1,
U>,<0,B1+B2,D>
820 M5=(ABS(S1-C1)+ABS(S2-C1))/X0:N5=(ABS(T1-C2)+ABS(T2-C2))/Y0
830 K=0
840 S3=S1-X0
850 PLOT <-3,-(B1+B2),U>
860 N5=INT(N5+.5)
870 FOR I3=1 TO N5+1
880 PLOT <6,0,D>,<,,U>
890 IF I3=N5+1 THEN 900:PLOT <-6,100,U>
900 NEXT I3
910 PLOT <-(A1+3),-(B2+6),U>
920 M5=INT(M5+.5)
930 FOR I4=1 TO M5+1
940 PLOT <0,12,D>,<,,U>
950 IF I4=M5+1 THEN 960:PLOT <100,-12,U>
960 NEXT I4
970 IF L1=2 THEN 980:PLOT <-(A1+A2+24),20,U>:GOTO 990
980 PLOT <-(A1+A2+24),-32,U>
990 FOR I=1 TO M5+1
1000 IF I>M5+1 THEN 1110
1010 S3=S3+X0
1020 IF ABS(S3)>=1000.THEN 1040:IF ABS(S3)>=100.THEN 1050:IF ABS
( S3)>=10.THEN 1060:IF ABS(S3)>=1.THEN 1070
1030 CONVERT S3 TO S3$,(-.###):GOTO 1080
1040 CONVERT S3 TO S3$,(-####):GOTO 1080
1050 CONVERT S3 TO S3$,(-###.):GOTO 1080
1060 CONVERT S3 TO S3$,(-##.#):GOTO 1080
1070 CONVERT S3 TO S3$,(-#.##):GOTO 1080
1080 IF K<>0 THEN 1090: PLOT <,,S3$>:GOTO 1110
1090 IF I-1<>INT(A1+.5)/100 THEN 1100:PLOT <100,0,U>:GOTO 1110
1100 PLOT <100-60,0,U>,<,,S3$>
1110 K=K+1:NEXT I
1120 IF L2=1 THEN 1130:PLOT <-(A2+18),0,U>:GOTO 1140
1130 PLOT <-(A2+90),0,U>
1140 IF L1=1 THEN 1150:PLOT < 0,-(B1-26),U>:GOTO 1160
1150 PLOT <0,-(B1+26),U>
1160 K=0
1170 T3=T1-Y0
```

TABLE VI CONT.

```
1180 FOR I2=1 TO N5+1
1190 IF I2>N5+1 THEN 1300
1200 T3=T3+Y0
1210 IF ABS(T3)>=1000.THEN 1230:IF ABS(T3)>=100.THEN 1240:IF ABS
(T3)>=10.THEN 1250:IF ABS(T3)>=1.THEN 1260
1220 CONVERT T3 TO T3$,(-.##):GOTO 1270
1230 CONVERT T3 TO T3$,(-####):GOTO 1270
1240 CONVERT T3 TO T3$,(-###.):GOTO 1270
1250 CONVERT T3 TO T3$,(-##.#):GOTO 1270
1260 CONVERT T3 TO T3$,(-#.#):GOTO 1270
1270 IF K<>0 THEN 1280:PLOT <,,T3$>:GOTO 1300
1280 IF I2-1<>INT(B1+.5)/100 THEN 1290:PLOT <0,100,U>:GOTO 1300
1290 PLOT <-48,100,U>,<,,T3$>
1300 K=K+1:NEXT I2
1310 IF X$=" " THEN 1370: PLOT <,,R>,<100*X1-A1,100*Y1,U>
1320 IF L1=2 THEN 1330:PLOT <0,50,U>:GOTO 1340
1330 PLOT <0,-60,U>
1340 IF A2<>0 THEN 1350:PLOT <A1/5,0,U>:GOTO 1360
1350 PLOT <A1+A2/5,0,U>
1360 PLOT <,,X$>
1370 IF Y$=" " THEN 1440
1380 PLOT <,,R>,<100*X1,100*Y1-B1,U>
1390 IF L2=1 THEN 1400:PLOT <90,0,U>:GOTO 1410
1400 PLOT <-90,0,U>
1410 IF B2<>0 THEN 1420:PLOT <0,2*B1/3,U>:GOTO 1430
1420 PLOT <0,B1+B2*2/3,U>
1430 PLOT <0,-20,S>,<,,Y$>,<13,,S>,<,,R>
1440 RETURN
1450 DEFFN'122(U,V,X4,Y4)
1460 X3=U:Y3=V
1470 D1=X3-X4:D2=Y3-Y4:X4=X4+D1:Y4=Y4+D2
1480 IF U1=2 THEN 1540
1490 IF U2=1 THEN 1520:PLOT <F1*D1,F2*D2,U>,<,,D>
1500 PLOT <,,D>:IF K/5=W THEN 1510:IF K=K5 THEN 1510:PLOT <,,U>
: GOTO 1530
1510 GOSUB 1720:W=W+1:PLOT <,,U>:GOTO 1530
1520 PLOT <F1*D1,U3,U>,<,,U>,<,,  >,<,,U>:
     E3=INT(U3):E7=INT(F1*D1):GOTO 1670
1530 E3=INT(F2*D2):E7=INT(F1*D1):RETURN
1540 E1=F2*Y3-INT(F2*Y3)
1550 E=E1+E4
1560 P8=F2*D2+E:P9=INT(P8)
1570 E5=F1*X3-INT(F1*X3)
1580 E6=E5+E8
1590 S8=F1*D1+E6:S9=INT(S8)
1600 IF U2=0 THEN 1610:PLOT <,,U>,<S9,0,U>:GOTO 1630
1610 IF U3=1 THEN 1620:PLOT <,,D>,<S9,P9,D>:GOTO 1630
1620 PLOT <,,U>,<S9,P9,U>:U3=0
```

TABLE VI CONT.

```
1630 IF U2=1 THEN 1640: E3=E3+P9
1640 E4=F2*Y3-E3
1650 E7=S9+E7
1660 E8=F1*X3-E7
1670 RETURN
1680 DEFFN'125: IF (Y-C2)/Y0+Y1<9.999THEN 1690:U2=1
1690 IF (Y-C2)/Y0+Y1>.001THEN 1700:U2=1
1700 IF (X-C1)/X0+X1<9.999THEN 1710:U2=1
1710 RETURN
1720 ON (VAL(P$)+1)GOSUB 1730,1740,1750:RETURN
1730 PLOT <0,8,U>,<-7,-12,D>,<14,0,D>,<-7,12,D>,<0,-8,U>:RETURN

1740 PLOT <0,6,U>,<-4,-12,D>,<10,8,D>,<-12,0,D>,<10,-8,D>,<-4,12
,D>,<0,-6,U>:RETURN
1750 PLOT <-4,7,D>,<8,0,D>,<-8,-14,D>,<8,0,D>,<-4,7,D>,<-7,4,D>,
<0,-8,D>,<14,8,D>,<0,-8,D>,<-7,4,D>,<0,0,U>:RETURN
1760 DEFFN'04:SELECT PRINT 005:PRINT HEX(03):PLOT <1,,C>,<,,S>
1770 PRINT "POSITION LABEL WHERE IT WILL NOT INTERFERE WITH GRAP
H"
1780 P$=" ":KEYIN P$,1800,1810
1790 GOTO 1780
1800 IF P$=HEX(0D) THEN 1880:IF P$=HEX(02) THEN 1830:IF P$=HEX(0
8) THEN 1840:PLOT <,,P$>,<13,,U>:GOTO 1780
1810 IF P$=HEX(05) THEN 1850:IF P$=HEX(06) THEN 1860:GOTO 1870
1820 PLOT <0,-20,U>,<-999,0,U>:GOTO 1780
1830 PLOT <13,0,U>:GOTO 1780
1840 PLOT <-13,0,U>:GOTO 1780
1850 PLOT <0,20,U>:GOTO 1780
1860 PLOT <0,-20,U>:GOTO 1780
1870 STOP
1880 RETURN
1890 PLOT <1,,C>,<14,,S>,<,,E$>
1900 PLOT <-238,-25,U>:PLOT <,,J$>
1910 PLOT <-140,-25,U>:PLOT <,,D$>
1920 PLOT <-98,-25,U>:GOSUB 1730:PLOT <18,,G$>
1930 PLOT <-214,-25,U>:GOSUB 1740:PLOT <18,,H$>
1940 PLOT <-228,-25,U>:GOSUB 1750:PLOT <18,,I$>,<,,R>
1950 RETURN
1960 PRINT "LOAD DATA TAPE IN UNIT 10A":INPUT "FILE NUMBER TO BE
 LOADED",N1
1970 SELECT TAPE 10A
1980 P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:NEXT K:IF N1=1 THEN 1990
:N=N1-1:SKIP NF
1990 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
IF END THEN 2000:GOTO 2000
2000 SELECT PRINT 215(132)
2010 PRINT "RSECS PPC02 DATA:FILE NUMBER";N1:PRINT
2020 PRINT "TEST DATE=";D$
```

TABLE VI CONCLUDED

```
2030 PRINT "TYPE OF CASE=";J$
2040 PRINT "VALUE OF X AT THE ORIGIN=";Z1
2050 PRINT "TOTAL NUMBER OF DATA POINTS=";D(8):PRINT
2060 PRINT ,"TIME","ARSIN","UPCAN","LOWCAN"
2070 PRINT "I","Q(I)","H(I)","P(I)","Q1(I)"
2080 FOR I=1 TO D(8)
2090 PRINT I,Q(I),H(I),P(I),Q1(I)
2100 NEXT I
2110 SELECT PRINT 005(64)
2120 STOP
```

LIOHCRT COMPUTER PROGRAM

File Name "LIOHCRT"

Abstract "LIOHCRT" plots the instantaneous removal rate of CO_2 from the LiOH canisters in lbm/min. The program produces a separate graph for both the upper and lower LiOH canisters using the LiOH test data previously saved on cassette tapes by the "LIOHPPC" program. Figures 7 and 8 provide examples of the plots produced by the program. The program is designed for use with the Wang 2200 series computer system with a flatbed plotter.

Program Description

The program takes data previously saved on cassette tapes by program "LIOHPPC" and calculates a CO_2 removal rate from the LiOH canisters. The formula used in the program is as follows:

$$\dot{M}\ C\ O\ 2\ (\text{REMOVAL}) = 0.07931 * \dot{V} * \Delta P/(T+459.67)$$

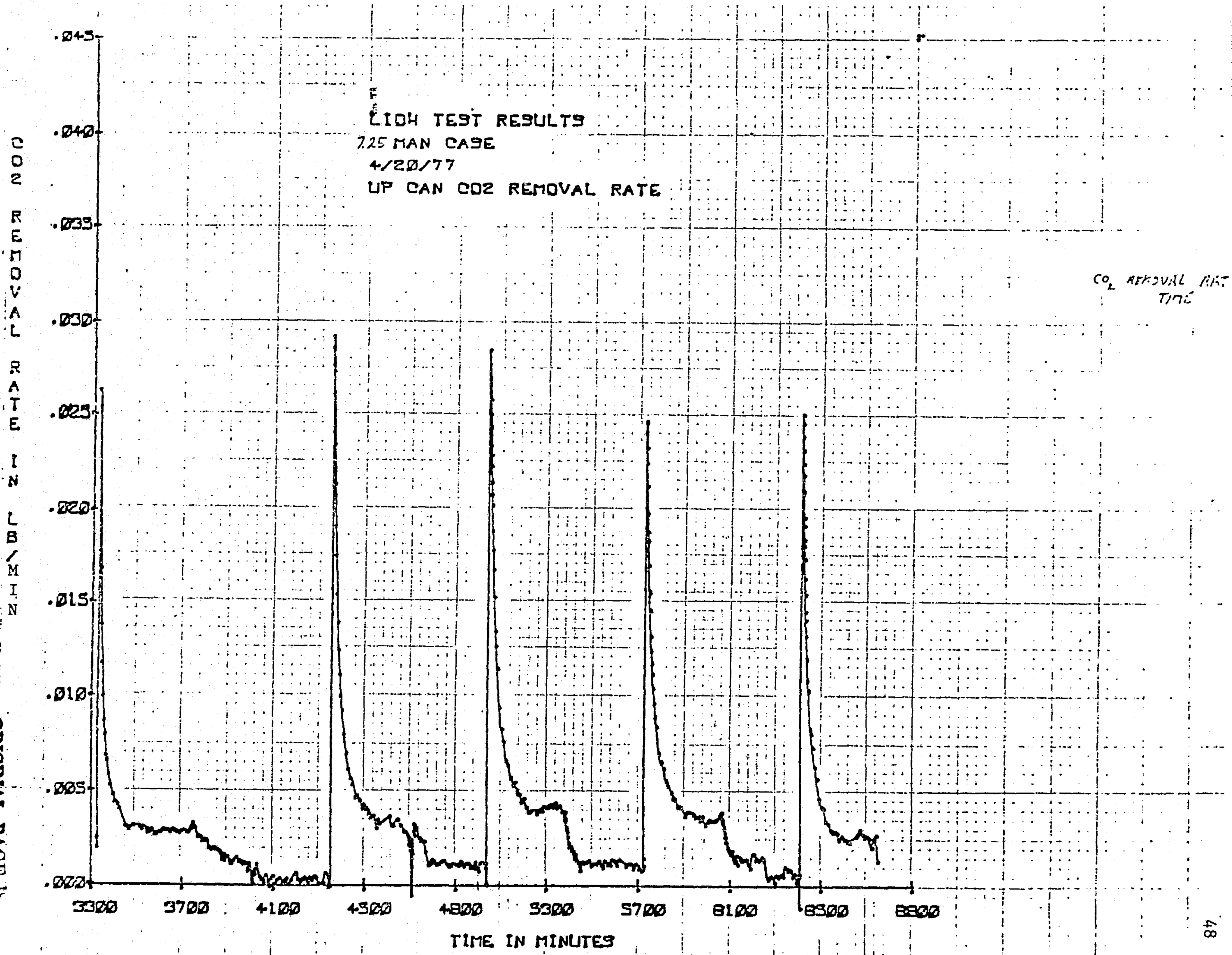
With $\dot{V}$ in CFM, P in mmHg, and T in deg F, the formula calculates the instantaneous removal rate of CO_2 in lbm/min. A full discussion of the derivation of this formula is included in Appendix 1.

The upper and lower LiOH canisters were changed out alternately with unique temperature and flow rates associated with each canister. The temperatures and flow rates used were the averaged values taken at canister insertion and removal, and are available in Memorandum EC2-77-185, "RSECS LiOH Test Data", dated 11-8-77. The length of time for a LiOH canister may encompass more than one file on the data tapes. The program first plots the upper canister removal rate and then the lower canister removal rate. Therefore, after loading a data tape in the tape drive unit, the program requests a file number, first and last data points to be plotted, and the temperature and flow rate associated with the first upper LiOH canister. The plotting is performed incrementally as data points are specified.

Any one file may not include all the data points associated with a canister. Therefore, another file, the first and last data points to be plotted and the temperature and flow rate must again be specified until all data points associated with the canister are reduced and plotted. When a specific canister is completed, either the next set of data points in a file or another file is required for the next canister. Thus, the file number, first and last data points to be plotted, and the temperature and flow rate for the new canister is requested by the program. In this way, the user will plot CO_2 removal rates for all of the upper canisters in a specific case.

The program provides labels for the plots, but requires that the user position the label where it will not interfere with the graph. Next, the program requests that the user replace the graph paper on the flatbed plotter before plotting the lower LiOH canister. After the graph paper has been changed, the procedure outlined for the upper canister is repeated for the lower canister. Figures 7 and 8 exemplify plots produced by the program for the 7 man case.

The program interfaces the input data with the generalized plot routine as a subroutine in order to produce the plots. A listing of the program "LIOHCRT" is provided in Table VII.



ORIGINAL PAGE IS OF POOR QUALITY

FIGURE 7. LIOHCRT PROGRAM EXAMPLE PLOT #1

ORIGINAL PAGE IS
OF POOR QUALITY

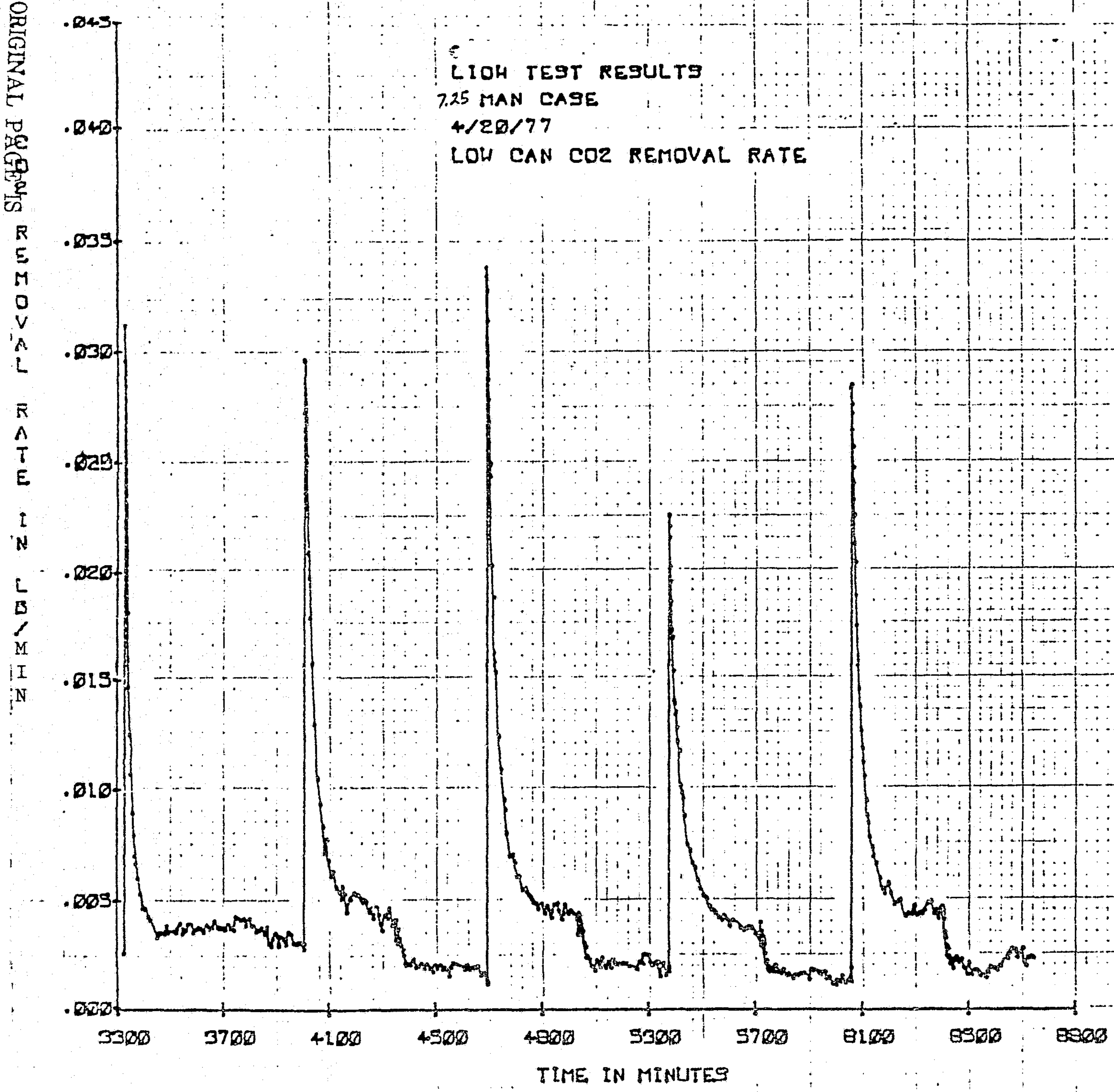


FIGURE 8 LIOHCRT PROGRAM EXAMPLE PLOT #2

TABLE VII LIOHCRT PROGRAM LISTING

```
10 REM LIOHCRT-PROGRAM PLOTS CO2 REMOVAL RATES FROM LIOH BEDS
       BASED UPON DATA FROM TAPES GENERATED BY LIOHPPC PROGRAM
20  COM X9(150),Y9(150),C(10),X$25,Y$25,P$1,C$30,D$20
30 COM E$20,F$20,Z1,G$25,H$25,I$,J$,R$20
40 COM Q(150),H(150),P(150),D(10),Q1(150)
50 E$="LIOH TEST RESULTS"
60 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE LO
ADED",N1 :SELECT TAPE 10B:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
   NEXT K:IF N1=1 THEN 70:N=N1-1:SKIP NF
70 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
                IF END THEN 80:GOTO 80
80 SELECT TAPE 10A:K6=D(8):X$="TIME IN MINUTES":Y$="CO2 REMOVAL
RATE IN LB/MIN"
90 R$=D$:X0=400:Y0=.005:X1=1:Y1=1:C1=Z1:C2=0:S1=Z1:S2=Z1+3600:T1
=0:T2=.045:L1=2:L2=1:GOSUB '00
100 PRINT "PLOTTING UPPPER CANNISTER"
110 G$="UP CAN CO2 REMOVAL RATE"
120 INPUT "FIRST AND LAST DATA POINTS=",I1,I2
130 INPUT "TEMP AND FLOW=",T,V5:K6=I2
140 Q$="FIGURE 1"
150 FOR I=I1 TO I2:X9(I)=Q(I):Y9(I)=V5*.07931/(459.67+T)*(H(I)-P
(I)):NEXT I
160 P$=HEX(00):D=1:K=1:K5=K6:L8=I1:L9=I2:GOSUB '03
170 FOR I=1 TO 150:X9(I)=0:Y9(I)=0:NEXT I
180 INPUT "MORE DATA POINTS? (0=NO,1=YES)",P3:IF P3=1 THEN 120
190 INPUT "ANOTHER FILE? (0=NO, 1=YES)",A:IF A=0 THEN 200:GOSUB
1790:GOTO 120
200 INPUT "DO YOU WISH TO LABEL GRAPH? (0=NO, 1=YES)",P:IF P=0 T
HEN 210:GOSUB '04:GOSUB 1720
210 PRINT "NOW PLOTTING LOWER CAN GRAPH, CHANGE PAPER":STOP :GOS
UB '00
220 INPUT "FIRST AND LAST DATA POINTS=",I1,I2
230 INPUT "TEMP AND FLOW=",T,V5:K6=I2:G$="LOW CAN CO2 REMOVAL RA
TE"
240 FOR I=I1 TO I2:X9(I)=Q(I):Y9(I)=V5*.07931/(459.67+T)*(H(I)-Q
1(I)):NEXT I
250 Q$="FIGURE 2"
260 P$=HEX(01):D=1:K=1:K5=K6:L8=I1:L9=I2:GOSUB '03
270 FOR I=1 TO 150:X9(I)=0:Y9(I)=0:NEXT I
280 INPUT "MORE DATA POINTS? (0=NO,1=YES)",P3:IF P3=1 THEN 220
290 INPUT "ANOTHER FILE? (0=NO, 1=YES)",A:IF A=0 THEN 300:GOSUB
1790:GOTO 220
300 INPUT "DO YOU WISH TO LABEL GRAPH? (0=NO, 1=YES)",P:IF P=0 T
HEN 320
310 GOSUB '04:GOSUB 1720
320 STOP
330 DEFFN' 00:Q=0:GOSUB 340:PLOT <,,R>:RETURN
340 SELECT PRINT 005: PRINT HEX(03):PRINT :PRINT :
```

TABLE VII CONT.

```
    PRINT "*** GENERATING PLOTS OF ";E$;" ***"
350 PRINT :PRINT :PRINT " IS PLOTTER POWER ON ?":PRINT " IS PLOT
 PAPER LOADED ? ":PRINT " IS CHART SWITCH ON HOLD ? ":PRINT " IS
 PEN IN DOWN POSITION AND CAP OFF ?"
360 PRINT " ARE SCALE LIMITS SET (0,0 BY 10,10) ?"
370 INPUT " IS ANSWER TO ALL ABOVE QUESTIONS YES ? (YES=1,NO=0)"
,Q:      IF Q<>1 THEN 340
380 SELECT PLOT 414:PLOT <1,,C>,<12,,S>:Q=0
390 F1=100/X0:F2=100/Y0:GOSUB 630:PLOT <1,,C>,<,,S>
400 RETURN
410 DEFFN'03:SELECT PRINT 005:PRINT HEX(03):
     PLOT <,,R>,<100*X1,100*Y1,U>,<1,,C>
420 X4,Y4,E,E3,E4,E6,E8,E7=0:U1=1:U3=0
430 K=1:X4,Y4=0
440 K1=K:W=1
450 U2=0:X=X9(K):IF X<Z1 THEN 500:IF X>S2 THEN 500:Y=Y9(K):IF Y>
T2 THEN 500:GOSUB '125:IF U2=1 THEN 520:X=X9(K)-C1:Y=Y9(K)-C2:X4
,Y4=0
460 IF K>K1 THEN 480:PLOT <,,R>,<100*X1,100*Y1,U>,<F1*X,F2*Y,U>
470 PLOT <,,D>:GOTO 490
480 GOSUB '122(X,Y,X4,Y4)
490 PLOT <-X*F1,-Y*F2,U>:GOTO 520
500 IF K/5=W THEN 510:GOTO 520
510 W=W+1
520 K=K+1:IF K>=K5+1 THEN 530:GOTO 450
530 X4,Y4,E,E3,E4,E6,E8,E7=0:U1=2:PLOT <,,R>,<100*X1,100*Y1,U>
540 FOR I=L8 TO L9
550 IF X9(I)<C1 THEN 600
560 X=X9(I)-C1:Y=Y9(I)-C2
570 IF X>3600 THEN 600:IF Y>T2 THEN 600
580 IF I<>L8 THEN 590:U1=1:GOSUB '122(X,Y,X4,Y4):U1=2:GOTO 610
590 GOSUB '122(X,Y,X4,Y4):GOTO 610
600 U3=1
610 NEXT I
620 PLOT <,,U>:PLOT <,,R>:RETURN
630 A1=F1*ABS(S1-C1):A2=F1*ABS(S2-C1):B1=F2*ABS(T1-C2):B2=F2*ABS
(T2-C2)
640 PLOT <,,R>,<100*X1,100*Y1,U>,<-A1,0,U>,<A1+A2,0,D>,<-A2,-B1,
U>,<0,B1+B2,D>
650 M5=(ABS(S1-C1)+ABS(S2-C1))/X0:N5=(ABS(T1-C2)+ABS(T2-C2))/Y0
660 K=0
670 S3=S1-X0
680 PLOT <-3,-(B1+B2),U>
690 N5=INT(N5+.5)
700 FOR I3=1 TO N5+1
710 PLOT <6,0,D>,<,,U>
720 IF I3=N5+1 THEN 730:PLOT <-6,100,U>
730 NEXT I3
```

TABLE VII CONT.

```
740 PLOT <-(A1+3),-(B2+6),U>
750 M5=INT(M5+.5)
760 FOR I4=1 TO M5+1
770 PLOT <0,12,D>,<,,U>
780 IF I4=M5+1 THEN 790:PLOT <100,-12,U>
790 NEXT I4
800 IF L1=2 THEN 810:PLOT <-(A1+A2+24),20,U>:GOTO 820
810 PLOT <-(A1+A2+24),-32,U>
820 FOR I=1 TO M5+1
830 IF I>M5+1 THEN 940
840 S3=S3+X0
850 IF ABS(S3)>=1000.THEN 870:IF ABS(S3)>=100.THEN 880:IF ABS( S
3)>=10.THEN 890:IF ABS(S3)>=1.THEN 900
860 CONVERT S3 TO S3$,(-.###):GOTO 910
870 CONVERT S3 TO S3$,(-####):GOTO 910
880 CONVERT S3 TO S3$,(-###.):GOTO 910
890 CONVERT S3 TO S3$,(-##.#):GOTO 910
900 CONVERT S3 TO S3$,(-#.##):GOTO 910
910 IF K<>0 THEN 920: PLOT <,,S3$>:GOTO 940
920 IF I-1<>INT(A1+.5)/100 THEN 930:PLOT <100,0,U>:GOTO 940
930 PLOT <100-60,0,U>,<,,S3$>
940 K=K+1:NEXT I
950 IF L2=1 THEN 960:PLOT <-(A2+18),0,U>:GOTO 970
960 PLOT <-(A2+95),0,U>
970 IF L1=1 THEN 980:PLOT < 0,-(B1-26),U>:GOTO 990
980 PLOT <0,-(B1+26),U>
990 K=0
1000 T3=T1-Y0
1010 FOR I2=1 TO N5+1
1020 IF I2>N5+1 THEN 1130
1030 T3=T3+Y0
1040 IF ABS(T3)>=1000.THEN 1060:IF ABS(T3)>=100.THEN 1070:IF ABS
(T3)>=10.THEN 1080:IF ABS(T3)>=1.THEN 1090
1050 CONVERT T3 TO T3$,(-.###):GOTO 1100
1060 CONVERT T3 TO T3$,(-####):GOTO 1100
1070 CONVERT T3 TO T3$,(-###.):GOTO 1100
1080 CONVERT T3 TO T3$,(-##.#):GOTO 1100
1090 CONVERT T3 TO T3$,(-#.##):GOTO 1100
1100 IF K<>0 THEN 1110:PLOT <,,T3$>:GOTO 1130
1110 IF I2-1<>INT(B1+.5)/100 THEN 1120:PLOT <0,100,U>:GOTO 1130
1120 PLOT <-60,100,U>,<,,T3$>
1130 K=K+1:NEXT I2
1140 IF X$=" " THEN 1200: PLOT <,,R>,<100*X1-A1,100*Y1,U>
1150 IF L1=2 THEN 1160:PLOT <0,50,U>:GOTO 1170
1160 PLOT <0,-60,U>
1170 IF A2<>0 THEN 1180:PLOT <A1/5,0,U>:GOTO 1190
1180 PLOT <A1+A2/2.25,0,U>
1190 PLOT <,,X$>
```

TABLE VII CONT.

```
1200 IF Y$=" " THEN 1270
1210 PLOT <,,R>,<100*X1,100*Y1-B1,U>
1220 IF L2=1 THEN 1230:PLOT <90,0,U>:GOTO 1240
1230 PLOT <-90,0,U>
1240 IF B2<>0 THEN 1250:PLOT <0,2*B1/3,U>:GOTO 1260
1250 PLOT <0,B1+B2*10.5/12,U>
1260 PLOT <0,-20,S>,<,,Y$>,<13,,S>,<,,R>
1270 RETURN
1280 DEFFN'122(U,V,X4,Y4)
1290 X3=U:Y3=V
1300 D1=X3-X4:D2=Y3-Y4:X4=X4+D1:Y4=Y4+D2
1310 IF U1=2 THEN 1370
1320 IF U2=1 THEN 1350:PLOT <F1*D1,F2*D2,U>,<,,D>
1330 PLOT <,,D>:PLOT <,,U> : GOTO 1360
1340 GOSUB 1550:W=W+1:PLOT <,,U>:GOTO 1360
1350 PLOT <F1*D1,U3,U>,<,,U>,<,,  >,<,,U>:
     E3=INT(U3):E7=INT(F1*D1):GOTO 1500
1360 E3=INT(F2*D2):E7=INT(F1*D1):RETURN
1370 E1=F2*Y3-INT(F2*Y3)
1380 E=E1+E4
1390 P8=F2*D2+E:P9=INT(P8)
1400 E5=F1*X3-INT(F1*X3)
1410 E6=E5+E8
1420 S8=F1*D1+E6:S9=INT(S8)
1430 IF U2=0 THEN 1440:PLOT <,,U>,<S9,0,U>:GOTO 1460
1440 IF U3=1 THEN 1450:PLOT <,,D>,<S9,P9,D>:GOTO 1460
1450 PLOT <,,U>,<S9,P9,U>:U3=0
1460 IF U2=1 THEN 1470: E3=E3+P9
1470 E4=F2*Y3-E3
1480 E7=S9+E7
1490 E8=F1*X3-E7
1500 RETURN
1510 DEFFN'125: IF (Y-C2)/Y0+Y1<9.999THEN 1520:U2=1
1520 IF (Y-C2)/Y0+Y1>.001THEN 1530:U2=1
1530 IF (X-C1)/X0+X1<9.999THEN 1540:U2=1
1540 RETURN
1550 ON (VAL(P$)+1)GOSUB 1560,1570,1580:RETURN
1560 PLOT <0,8,U>,<-7,-12,D>,<14,0,D>,<-7,12,D>,<0,-8,U>:RETURN

1570 PLOT <0,6,U>,<-4,-12,D>,<10,8,D>,<-12,0,D>,<10,-8,D>,<-4,12
,D>,<0,-6,U>:RETURN
1580 PLOT <-4,7,D>,<8,0,D>,<-8,-14,D>,<8,0,D>,<-4,7,D>,<-7,4,D>,
<0,-8,D>,<14,8,D>,<0,-8,D>,<-7,4,D>,<0,0,U>:RETURN
1590 DEFFN'04:SELECT PRINT 005:PRINT HEX(03):PLOT <1,,C>,<,,S>
1600 PRINT "POSITION LABEL WHERE IT WILL NOT INTERFERE WITH GRAP
H"
1610 P$=" ":KEYIN P$,1630,1640
1620 GOTO 1610
```

TABLE VII CONCLUDED

```
1630 IF P$=HEX(0D) THEN 1710:IF P$=HEX(02) THEN 1660:IF P$=HEX(0
8) THEN 1670:PLOT <,,P$>,<13,,U>:GOTO 1610
1640 IF P$=HEX(05) THEN 1680:IF P$=HEX(06) THEN 1690:GOTO 1700
1650 PLOT <0,-20,U>,<-999,0,U>:GOTO 1610
1660 PLOT <13,0,U>:GOTO 1610
1670 PLOT <-13,0,U>:GOTO 1610
1680 PLOT <0,20,U>:GOTO 1610
1690 PLOT <0,-20,U>:GOTO 1610
1700 STOP
1710 RETURN
1720 PLOT <1,,C>,<14,,S>,<,,Q$>
1730 PLOT <-112,-25,U>:PLOT <,,E$>
1740 PLOT <-238,-25,U>:PLOT <,,J$>
1750 PLOT <-140,-25,U>:PLOT <,,R$>
1760 PLOT <-98,-25,U>:PLOT <,,G$>
1770 PLOT <,,R>
1780 RETURN
1790 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE
LOADED",N1 :SELECT TAPE 10B:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
     NEXT K:IF N1=1 THEN 70:N=N1-1:SKIP NF
1800 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
                 IF END THEN 1810:GOTO 1810
1810 SELECT TAPE 10A:K6=D(8):X$="TIME IN MINUTES":Y$="CO2 REMOVA
L RATE IN LB/HR"
1820 RETURN
```

LIOHMAC COMPUTER PROGRAM

File Name "LIOHMAC"

Abstract "LIOHMAC" plots the accumulation of mass of CO_2 in the LiOH canisters in lbm. The program produces a separate plot for the upper and the lower canisters using the LiOH test data previously stored on cassette tapes by the "LIOHPPC" program. Figures 9 and 10 provide examples of the plots produced by the program. The program is designed for use with the Wang 2200 series computer system with a flatbed plotter.

Program Description

The program utilizes data previously saved on cassette tapes by program "LIOHPPC" to calculate an accumulation of mass of CO_2 in the LiOH canisters. The basic formula used in the program is as follows:

MASS ACCUMULATED (lbm) = RATE OF MASS REMOVAL (lbm/min)* DELTA TIME (min)

RATE OF MASS REMOVAL (lbm/min)= $0.07931*\dot{V}*\Delta P/(T+459.67)$

where $\dot{V}$ is in CFM, P is in mmHg, and T is in degrees F. The formula for rate of removal is the same as used in program "LIOHCRT" and is fully discussed in Appendix 1. The program "LIOHMAC" functions exactly the same way as "LIOHCRT" with the expanded formula being the primary difference. Therefore, the user may refer to the program description of "LIOHCRT" for an explanation of the required input data and program operation.

Figures 9 and 10 exemplify plots produced by the program for the 7 man case. The program interfaces the input data with the generalized plot routine as a subroutine in order to produce the plots. A listing of the program "LIOHMAC" is provided in Table VIII.

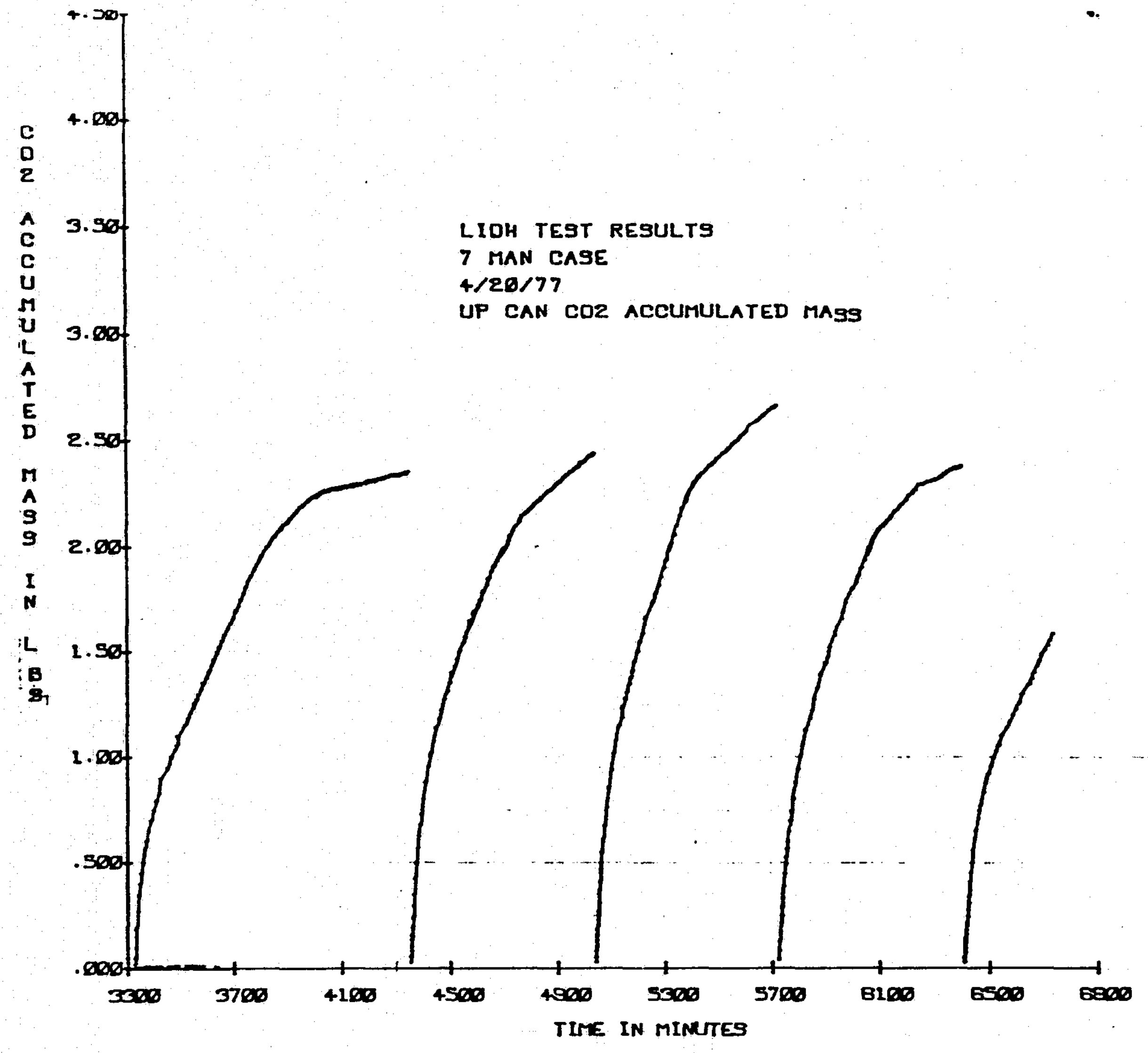


FIGURE 9 LIOHMAC PROGRAM EXAMPLE PLOT #1

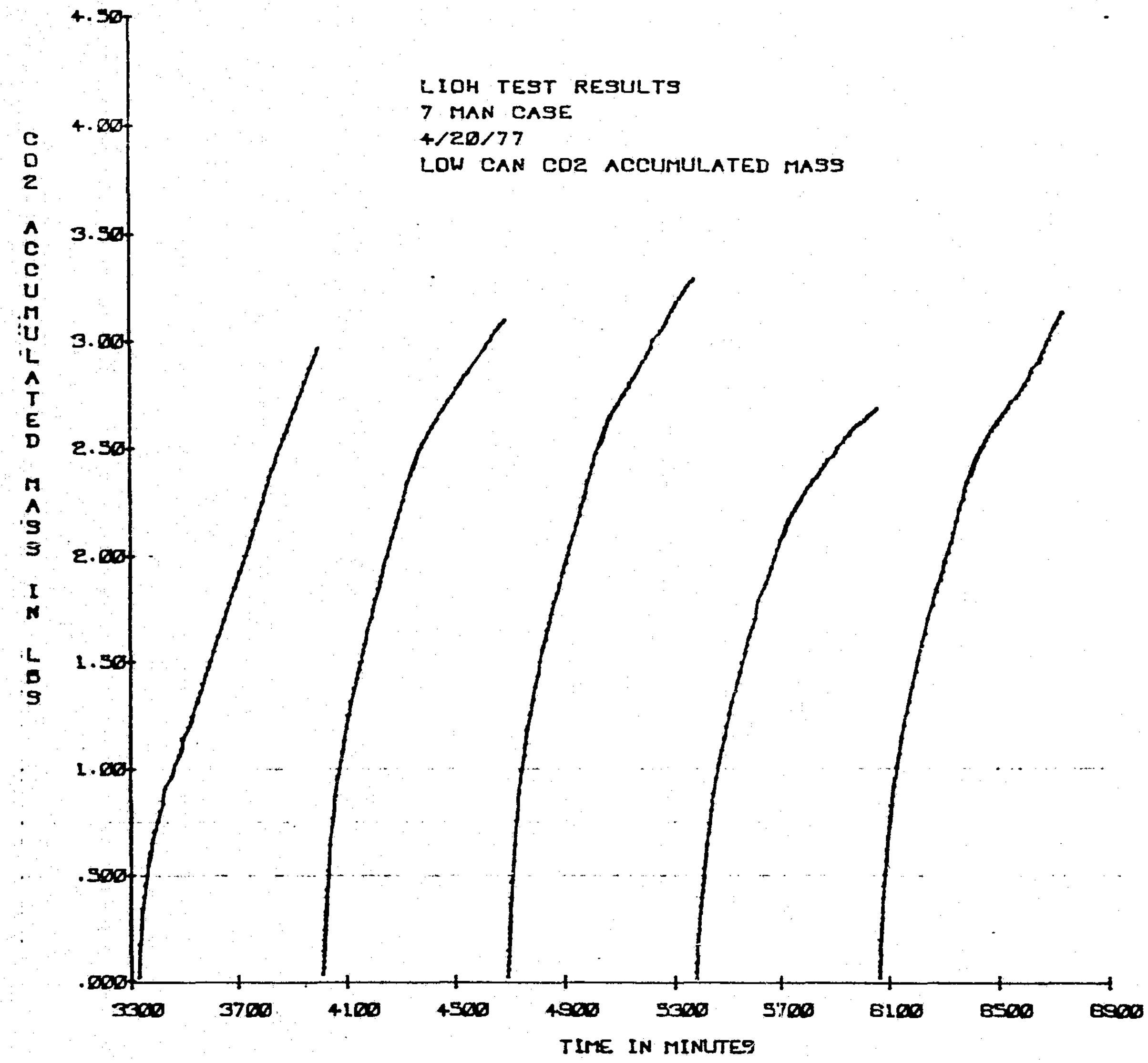


FIGURE 10 LIOHMAC PROGRAM EXAMPLE PLOT #2

TABLE VIII LIOHMAC PROGRAM LISTING

```
10 REM LIOHMAC-PROGRAM PLOTS CO2 ACCUMULATION IN LIOH BEDS
    BASED UPON DATA FROM TAPES GENERATED BY LIOHPPC PROGRAM
20  COM X9(150),Y9(150),C(10),X$25,Y$25,P$1,C$30,D$20
30 COM E$20,F$20,Z1,G$25,H$25,I$,J$,R$20
40 COM Q(150),H(150),P(150),D(10),Q1(150)
50 E$="LIOH TEST RESULTS"
60 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE LO
ADED",N1 :SELECT TAPE 10B:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
   NEXT K:IF N1=1 THEN 70:N=N1-1:SKIP NF
70 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
               IF END THEN 80:GOTO 80
80 SELECT TAPE 10A:K6=D(8):X$="TIME IN MINUTES":Y$="CO2 ACCUMULA
TION IN LBS"
90 R$=D$:X0=400:Y0=.5:X1=1:Y1=1:C1=Z1:C2=0:S1=Z1:S2=Z1+3600:T1=0
:T2=4.5:L1=2:L2=1:GOSUB '00
100 PRINT "PLOTTING UPPPER CANNISTER"
110 G$="UP CAN CO2 ACCUMULATED MASS"
120 INPUT "FIRST AND LAST DATA POINTS=",I1,I2
130 INPUT "TEMP AND FLOW=",T,V5:K6=I2
140 Q$="FIGURE 1"
150 FOR I=I1 TO I2:Y9(I1-1)=Y9(I1-1)+M
160 X9(I)=Q(I):Y9(I)=V5*.07931/(459.67+T)*(H(I)-P(I))*(((Q(I)+Q(
I+1))/2)-((Q(I-1)+Q(I))/2))+Y9(I-1):NEXT I
170 M=Y9(I2)
180 P$=HEX(00):D=1:K=1:K5=K6:L8=I1:L9=I2:GOSUB '03
190 FOR I=1 TO 150:X9(I)=0:Y9(I)=0:NEXT I
200 INPUT "ANOTHER FILE? (0=NO, 1=YES)",A:IF A=0 THEN 210:GOSUB
1860:GOTO 120
210 M=0:INPUT "MORE DATA POINTS? (0=NO,1=YES)",P3:IF P3=1 THEN 1
20
220 INPUT "DO YOU WISH TO LABEL GRAPH? (0=NO, 1=YES)",P:IF P=0 T
HEN 230:GOSUB '04:GOSUB 1790
230 PRINT "NOW PLOTTING LOWER CAN GRAPH, CHANGE PAPER":STOP :GOS
UB '00
240 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE L
OADED",N1 :SELECT TAPE 10A:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
    NEXT K:IF N1=1 THEN 70:N=N1-1:SKIP NF
250 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
               IF END THEN 260:GOTO 260
260 SELECT TAPE 10A:K6=D(8):X$="TIME IN MINUTES":Y$="CO2 ACCUMUL
ATION IN LBS"
270 INPUT "FIRST AND LAST DATA POINTS=",I1,I2
280 INPUT "TEMP AND FLOW=",T,V5:K6=I2:G$="LOW CAN CO2 ACCUMULATE
D MASS"
290 FOR I=I1 TO I2:Y9(I1-1)=Y9(I1-1)+M
300 X9(I)=Q(I):Y9(I)=V5*.07931/(459.67+T)*(H(I)-P(I))*(((Q(I)+Q(
I+1))/2)-((Q(I-1)+Q(I))/2))+Y9(I-1):NEXT I
310 M=Y9(I2)
320 Q$="FIGURE 2"
```

TABLE VIII CONT.

```
330 P$=HEX(01):D=1:K=1:K5=K6:L8=I1:L9=I2:GOSUB '03
340 FOR I=1 TO 150:X9(I)=0:Y9(I)=0:NEXT I
350 INPUT "ANOTHER FILE? (0=NO, 1=YES)",A:IF A=0 THEN 360:GOSUB
1860:GOTO 270
360 M=0:INPUT "MORE DATA POINTS? (0=NO,1=YES)",P3:IF P3=1 THEN 2
70
370 INPUT "DO YOU WISH TO LABEL GRAPH? (0=NO, 1=YES)",P:IF P=0 T
HEN 390
380 GOSUB '04:GOSUB 1790
390 STOP
400 DEFFN' 00:Q=0:GOSUB 410:PLOT <,,R>:RETURN
410 SELECT PRINT 005: PRINT HEX(03):PRINT :PRINT :
    PRINT "*** GENERATING PLOTS OF ";E$;" ***"
420 PRINT :PRINT :PRINT " IS PLOTTER POWER ON ?":PRINT " IS PLOT
 PAPER LOADED ? ":PRINT " IS CHART SWITCH ON HOLD ? ":PRINT " IS
 PEN IN DOWN POSITION AND CAP OFF ?"
430 PRINT " ARE SCALE LIMITS SET (0,0 BY 10,10) ?"
440 INPUT " IS ANSWER TO ALL ABOVE QUESTIONS YES ? (YES=1,NO=0)"
,Q:      IF Q<>1 THEN 410
450 SELECT PLOT 414:PLOT <1,,C>,<12,,S>:Q=0
460 F1=100/X0:F2=100/Y0:GOSUB 700:PLOT <1,,C>,<,,S>
470 RETURN
480 DEFFN'03:SELECT PRINT 005:PRINT HEX(03):
     PLOT <,,R>,<100*X1,100*Y1,U>,<1,,C>
490 X4,Y4,E,E3,E4,E6,E8,E7=0:U1=1:U3=0
500 K=1:X4,Y4=0
510 K1=K:W=1
520 U2=0:X=X9(K):IF X<Z1 THEN 570:IF X>S2 THEN 570:Y=Y9(K):IF Y>
T2 THEN 570:GOSUB '125:IF U2=1 THEN 590:X=X9(K)-C1:Y=Y9(K)-C2:X4
,Y4=0
530 IF K>K1 THEN 550:PLOT <,,R>,<100*X1,100*Y1,U>,<F1*X,F2*Y,U>
540 PLOT <,,D>:GOTO 560
550 GOSUB '122(X,Y,X4,Y4)
560 PLOT <-X*F1,-Y*F2,U>:GOTO 590
570 IF K/5=W THEN 580:GOTO 590
580 W=W+1
590 K=K+1:IF K>=K5+1 THEN 600:GOTO 520
600 X4,Y4,E,E3,E4,E6,E8,E7=0:U1=2:PLOT <,,R>,<100*X1,100*Y1,U>
610 FOR I=L8 TO L9
620 IF X9(I)<C1 THEN 670
630 X=X9(I)-C1:Y=Y9(I)-C2
640 IF X>3600 THEN 670:IF Y>T2 THEN 670
650 IF I<>L8 THEN 660:U1=1:GOSUB '122(X,Y,X4,Y4):U1=2:GOTO 680
660 GOSUB '122(X,Y,X4,Y4):GOTO 680
670 U3=1
680 NEXT I
690 PLOT <,,U>:PLOT <,,R>:RETURN
700 A1=F1*ABS(S1-C1):A2=F1*ABS(S2-C1):B1=F2*ABS(T1-C2):B2=F2*ABS
(T2-C2)
```

TABLE VIII CONT.

```
710 PLOT <,,R>,<100*X1,100*Y1,U>,<-A1,0,U>,<A1+A2,0,D>,<-A2,-B1,
U>,<0,B1+B2,D>
720 M5=(ABS(S1-C1)+ABS(S2-C1))/X0:N5=(ABS(T1-C2)+ABS(T2-C2))/Y0
730 K=0
740 S3=S1-X0
750 PLOT <-3,-(B1+B2),U>
760 N5=INT(N5+.5)
770 FOR I3=1 TO N5+1
780 PLOT <6,0,D>,<,,U>
790 IF I3=N5+1 THEN 800:PLOT <-6,100,U>
800 NEXT I3
810 PLOT <-(A1+3),-(B2+6),U>
820 M5=INT(M5+.5)
830 FOR I4=1 TO M5+1
840 PLOT <0,12,D>,<,,U>
850 IF I4=M5+1 THEN 860:PLOT <100,-12,U>
860 NEXT I4
870 IF L1=2 THEN 880:PLOT <-(A1+A2+24),20,U>:GOTO 890
880 PLOT <-(A1+A2+24),-32,U>
890 FOR I=1 TO M5+1
900 IF I>M5+1 THEN 1010
910 S3=S3+X0
920 IF ABS(S3)>=1000.THEN 940:IF ABS(S3)>=100.THEN 950:IF ABS( S
3)>=10.THEN 960:IF ABS(S3)>=1.THEN 970
930 CONVERT S3 TO S3$,(-.###):GOTO 980
940 CONVERT S3 TO S3$,(-####):GOTO 980
950 CONVERT S3 TO S3$,(-###.):GOTO 980
960 CONVERT S3 TO S3$,(-##.#):GOTO 980
970 CONVERT S3 TO S3$,(-#.##):GOTO 980
980 IF K<>0 THEN 990: PLOT <,,S3$>:GOTO 1010
990 IF I-1<>INT(A1+.5)/100 THEN 1000:PLOT <100,0,U>:GOTO 1010
1000 PLOT <100-60,0,U>,<,,S3$>
1010 K=K+1:NEXT I
1020 IF L2=1 THEN 1030:PLOT <-(A2+18),0,U>:GOTO 1040
1030 PLOT <-(A2+95),0,U>
1040 IF L1=1 THEN 1050:PLOT < 0,-(B1-26),U>:GOTO 1060
1050 PLOT <0,-(B1+26),U>
1060 K=0
1070 T3=T1-Y0
1080 FOR I2=1 TO N5+1
1090 IF I2>N5+1 THEN 1200
1100 T3=T3+Y0
1110 IF ABS(T3)>=1000.THEN 1130:IF ABS(T3)>=100.THEN 1140:IF ABS
(T3)>=10.THEN 1150:IF ABS(T3)>=1.THEN 1160
1120 CONVERT T3 TO T3$,(-.###):GOTO 1170
1130 CONVERT T3 TO T3$,(-####):GOTO 1170
1140 CONVERT T3 TO T3$,(-###.):GOTO 1170
1150 CONVERT T3 TO T3$,(-##.#):GOTO 1170
1160 CONVERT T3 TO T3$,(-#.##):GOTO 1170
```

TABLE VIII CONT.

```
1170 IF K<>0 THEN 1180:PLOT <,,T3$>:GOTO 1200
1180 IF I2-1<>INT(B1+.5)/100 THEN 1190:PLOT <0,100,U>:GOTO 1200
1190 PLOT <-60,100,U>,<,,T3$>
1200 K=K+1:NEXT I2
1210 IF X$=" " THEN 1270: PLOT <,,R>,<100*X1-A1,100*Y1,U>
1220 IF L1=2 THEN 1230:PLOT <0,50,U>:GOTO 1240
1230 PLOT <0,-60,U>
1240 IF A2<>0 THEN 1250:PLOT <A1/5,0,U>:GOTO 1260
1250 PLOT <A1+A2/2.25,0,U>
1260 PLOT <,,X$>
1270 IF Y$=" " THEN 1340
1280 PLOT <,,R>,<100*X1,100*Y1-B1,U>
1290 IF L2=1 THEN 1300:PLOT <90,0,U>:GOTO 1310
1300 PLOT <-90,0,U>
1310 IF B2<>0 THEN 1320:PLOT <0,2*B1/3,U>:GOTO 1330
1320 PLOT <0,B1+B2*10.5/12,U>
1330 PLOT <0,-20,S>,<,,Y$>,<13,,S>,<,,R>
1340 RETURN
1350 DEFFN'122(U,V,X4,Y4)
1360 X3=U:Y3=V
1370 D1=X3-X4:D2=Y3-Y4:X4=X4+D1:Y4=Y4+D2
1380 IF U1=2 THEN 1440
1390 IF U2=1 THEN 1420:PLOT <F1*D1,F2*D2,U>,<,,D>
1400 PLOT <,,D>:PLOT <,,U> : GOTO 1430
1410 GOSUB 1620:W=W+1:PLOT <,,U>:GOTO 1430
1420 PLOT <F1*D1,U3,U>,<,,U>,<,,  >,<,,U>:
     E3=INT(U3):E7=INT(F1*D1):GOTO 1570
1430 E3=INT(F2*D2):E7=INT(F1*D1):RETURN
1440 E1=F2*Y3-INT(F2*Y3)
1450 E=E1+E4
1460 P8=F2*D2+E:P9=INT(P8)
1470 E5=F1*X3-INT(F1*X3)
1480 E6=E5+E8
1490 S8=F1*D1+E6:S9=INT(S8)
1500 IF U2=0 THEN 1510:PLOT <,,U>,<S9,0,U>:GOTO 1530
1510 IF U3=1 THEN 1520:PLOT <,,D>,<S9,P9,D>:GOTO 1530
1520 PLOT <,,U>,<S9,P9,U>:U3=0
1530 IF U2=1 THEN 1540: E3=E3+P9
1540 E4=F2*Y3-E3
1550 E7=S9+E7
1560 E8=F1*X3-E7
1570 RETURN
1580 DEFFN'125: IF (Y-C2)/Y0+Y1<9.999THEN 1590:U2=1
1590 IF (Y-C2)/Y0+Y1>.001THEN 1600:U2=1
1600 IF (X-C1)/X0+X1<9.999THEN 1610:U2=1
1610 RETURN
1620 ON (VAL(P$)+1)GOSUB 1630,1640,1650:RETURN
1630 PLOT <0,8,U>,<-7,-12,D>,<14,0,D>,<-7,12,D>,<0,-8,U>:RETURN
1640 PLOT <0,6,U>,<-4,-12,D>,<10,8,D>,<-12,0,D>,<10,-8,D>,<-4,12
```

TABLE VIII CONCLUDED

```
,D>,<0,-6,U>:RETURN
1650 PLOT <-4,7,D>,<8,0,D>,<-8,-14,D>,<8,0,D>,<-4,7,D>,<-7,4,D>,
<0,-8,D>,<14,8,D>,<0,-8,D>,<-7,4,D>,<0,0,U>:RETURN
1660 DEFFN'04:SELECT PRINT 005:PRINT HEX(03):PLOT <1,,C>,<,,S>
1670 PRINT "POSITION LABEL WHERE IT WILL NOT INTERFERE WITH GRAP
H"
1680 P$=" ":KEYIN P$,1700,1710
1690 GOTO 1680
1700 IF P$=HEX(OD) THEN 1780:IF P$=HEX(02) THEN 1730:IF P$=HEX(0
8) THEN 1740:PLOT <,,P$>,<13,,U>:GOTO 1680
1710 IF P$=HEX(05) THEN 1750:IF P$=HEX(06) THEN 1760:GOTO 1770
1720 PLOT <0,-20,U>,<-999,0,U>:GOTO 1680
1730 PLOT <13,0,U>:GOTO 1680
1740 PLOT <-13,0,U>:GOTO 1680
1750 PLOT <0,20,U>:GOTO 1680
1760 PLOT <0,-20,U>:GOTO 1680
1770 STOP
1780 RETURN
1790 PLOT <1,,C>,<14,,S>,<,,Q$>
1800 PLOT <-112,-25,U>:PLOT <,,E$>
1810 PLOT <-238,-25,U>:PLOT <,,J$>
1820 PLOT <-140,-25,U>:PLOT <,,R$>
1830 PLOT <-98,-25,U>:PLOT <,,G$>
1840 PLOT <,,R>
1850 RETURN
1860 PRINT "LOAD DATA TAPE ON UNIT B ":INPUT "FILE NUMBER TO BE
LOADED",N1 :SELECT TAPE 10B:P9=0:REWIND :FOR K=1 TO 50:P9=P9+1:
     NEXT K:IF N1=1 THEN 70:N=N1-1:SKIP NF
1870 DATA LOAD "LTEST":DATA LOAD D$,J$,Z1,D(8),Q(),H(),P(),Q1():
                 IF END THEN 1880:GOTO 1880
1880 SELECT TAPE 10A:K6=D(8):X$="TIME IN MINUTES":Y$="CO2 ACCUMU
LATION IN LBS"
1890 RETURN
```

BLOCKF COMPUTER PROGRAM

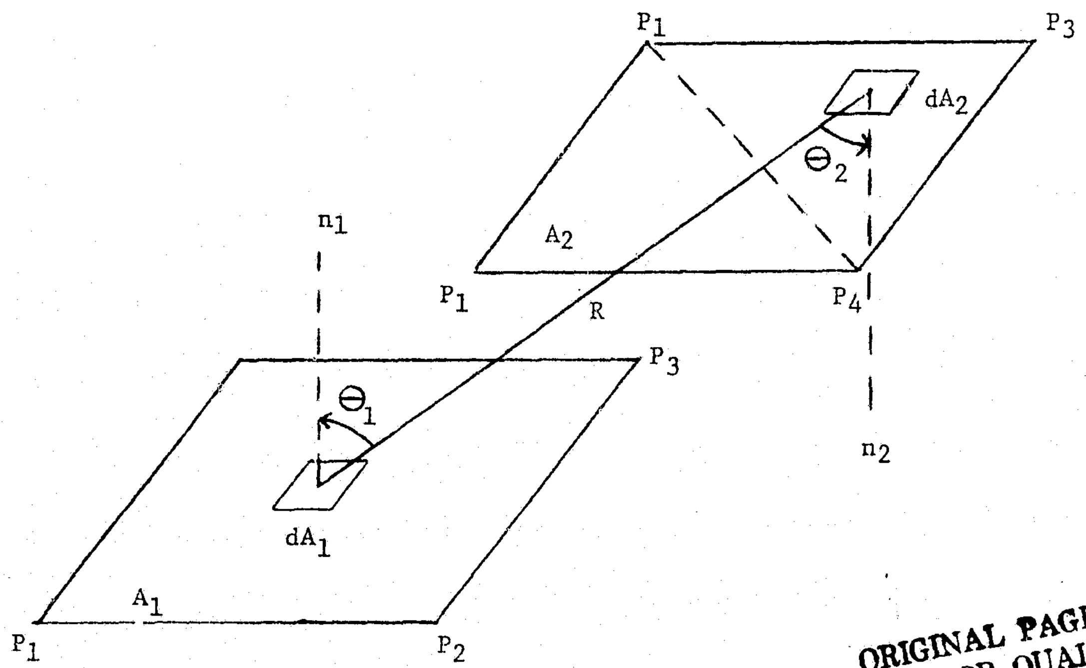
File Name "BLOCKF"

Abstract This program will numerically approximate the radiation view factor (F) between a rectangle and an N-sided polygon. Internally, the program subdivides the N-sided polygon into N-2 triangles and calculates the view factor from the rectangle to the N-2 triangles. With the use of form factor algebra, the program combines the triangles back into a polygon. This program only operates on two surfaces at a time and will not include the effects of a shadowing surface. For a detailed explanation of a radiation view factor, see reference 1. The program is designed for use with a Wang 2200 series mini computer. A sample case is included in figure 10.

Program Description

The program numerically calculates the view factor (F) according to the following equation:

$$F_{A_1-A_2} = \frac{1}{A_1}\int_{A_1}\int_{A_2}\frac{\cos\Theta 1 \ \cos\Theta 2 \ dA_1 \ dA_2}{\pi R^2}$$



The required inputs to perform the calculations are as follows:

1. Number of sides of A_2 (the polygon, MAX=20)
2. X,Y,Z co-ordinates of each corner of the polygon (must be entered sequentially counter clockwise).

3. XYZ of three corners of A_1, the rectangle (must be entered sequentially counter clockwise).

4. Grid size of the rectangle. The grid size is actually the size of the element dA_1. The more subdivisions the more accurate the results and more computer time used.

The program outputs the following results on the CRT screen:

1. The area of each surface.
2. The view factors F_{1-2} and F_{2-1}.

At this point, the user is given the option to select a different grid size (see sample case).

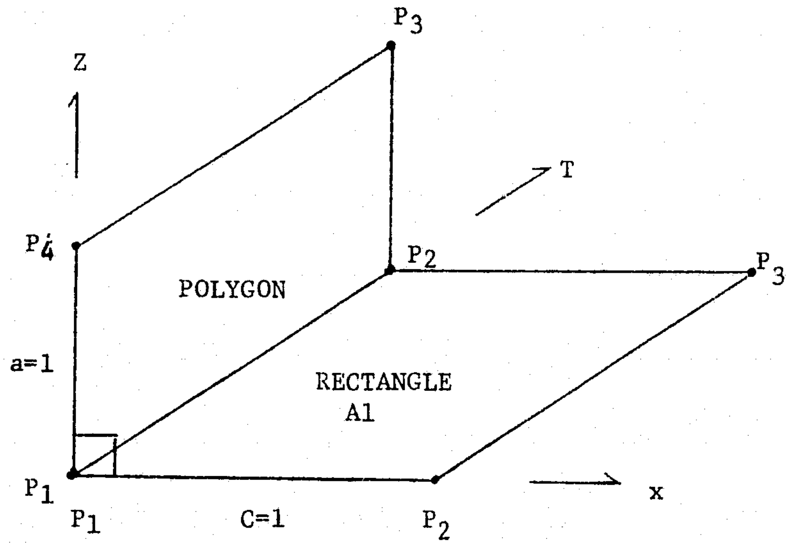
A sample case of "BLOCKF" is provided in figure 11 and a listing of the program is provided in Table IX.

Reference 1

Hamilton D.C. and W. R. Morgan, "Radiant Interchange Configuration Factors," NACA Technical Note 2836, 1952.

FIGURE 11

BLOCKF SAMPLE CASE



$F_{1-2} = F_{2-1} = .20004$

from Reference 1

INPUTS

A_1	x	y	z
P_1	0	0	0
P_2	1	0	0
P_3	1	1	0

A_2	x	y	z
P_1	0	0	0
P_2	0	1	0
P_3	0	1	1
P_4	0	0	1

OUTPUTS

GRID SIZE	F
2	.198
4	.19956
8	.19993
16	.20001

TABLE IX BLOCKF PROGRAM LISTING

```
10 DIM X(21),Y(21),Z(21),U(3),V(3),W(3)
20 INPUT " NUMBER OF SIDES OF VIEWED POLYGON, M (MAX=20) ",M
30 PRINT "INPUT P1 .... PM OF VIEWED POLYGON "
40 FOR I= 1 TO M
50 PRINT "P";I;:INPUT X(I),Y(I),Z(I)
60 NEXT I
70 X(M+1)=X(1):Y(M+1)=Y(1):Z(M+1)=Z(1)
80 PRINT " INPUT P1,P2,P3 OF VIEWING RECTANGLE "
90 FOR I=1 TO 3
100 PRINT "P";I;:INPUT U(I),V(I),W(I)
110 NEXT I
120 PRINT :PRINT " VIEWED SURFACE  (SURFACE 2) "
130 FOR I=1 TO M
140 PRINT "P";I;"=";X(I);",";Y(I);",";Z(I)
150 NEXT I
160 STOP " KEY CONTINUE "
170 PRINT :PRINT " VIEWING SURFACE  (SURFACE 1) "
180 FOR I=1 TO 3
190 PRINT "P";I;"=";U(I);",";V(I);",";W(I)
200 NEXT I
210 M2=0:FOR I=2 TO (M-1)
220 A1=X(1)-X(I):A2=Y(1)-Y(I):A3=Z(1)-Z(I)
230 B1=X(1)-X(I+1):B2=Y(1)-Y(I+1):B3=Z(1)-Z(I+1)
240 C1=A2*B3-A3*B2:C2=A3*B1-A1*B3:C3=A1*B2-A2*B1
250 C0=C1*C1+C2*C2+C3*C3:C0=SQR(C0)
260 M2=M2+C0
270 NEXT I : M2=.5*M2
280 A1=U(3)-U(2)
290 A2=V(3)-V(2)
300 A3=W(3)-W(2)
310 B1=U(1)-U(2)
320 B2=V(1)-V(2)
330 B3=W(1)-W(2)
340 REM C = A CROSS B
350 C1=A2*B3-A3*B2
360 C2=A3*B1-A1*B3
370 C3=A1*B2-A2*B1
380 M1=(C1*C1+C2*C2+C3*C3):M1=SQR(M1)
390 N1=C1/M1:N2=C2/M1:N3=C3/M1
400 INPUT "GRID SIZE OF VIEWING SURFACE ",G0:G1=G0-1
410 PRINT HEX(03) :PRINT " GRID SIZE OF VIEWING SURFACE = ";G0
420 D1=U(2)+.5*(A1+B1)/G0
430 D2=V(2)+.5*(A2+B2)/G0
440 D3=W(2)+.5*(A3+B3)/G0
450 SELECT R : S9=0:REM CALCULATE LOCATION ON VIEWING SURFACE
460 FOR K=0 TO G1:FOR J=0 TO G1
470 R1=D1+(J*A1+K*B1)/G0
480 R2=D2+(J*A2+K*B2)/G0
490 R3=D3+(J*A3+K*B3)/G0
```

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OF POOR QUALITY

TABLE IX CONCLUDED

```
500 FOR L=1 TO M
510 R4=X(L)-R1
520 R5=Y(L)-R2
530 R6=Z(L)-R3
540 R7=X(L+1)-X(L)
550 R8=Y(L+1)-Y(L)
560 R9=Z(L+1)-Z(L)
570 S1=R7*(R5*N3-R6*N2)-R8*(R4*N3-R6*N1)+R9*(R4*N2-R5*N1)
580 S2=R4*R4+R5*R5+R6*R6
590 S3=2*(R4*R7+R5*R8+R6*R9)
600 S4=R7*R7+R8*R8+R9*R9
610 S5=4*S2*S4-S3*S3
620 S6=SQR(S5)
630 S7=S1/(#PI*S6)
640 S8=ATN((2*S4+S3)/S6) - ATN(S3/S6)
650 S8=S8*S7
660 S9=S9+S8
670 NEXT L:NEXT J:NEXT K
680 S9=S9/(G0*G0)
690 PRINT :PRINT "F(1,2)= ";ABS(S9)
700 PRINT "F(2,1)= ";ABS(S9)*M1/M2
710 PRINT "  A(1)= ";M1
720 PRINT "  A(2)= ";M2:PRINT
730 G1=0:INPUT "ANOTHER GRID SIZE (1=YES, 0=NO)",G1:IF G1 =0 THE
N 740:GOTO 400
740 END
```

SCRIPTF COMPUTER PROGRAM

File Name "SCRIPTF"

Abstract This program calculates radiation exchange factors from a user provided view factor matrix, area vector and emitance vector. The program is designed for use with a Wang 2200 series mini computer system with the Matrix ROM Option.

Program Description

This program calculates the radiation exchange factors $\mathcal{F}$ for use in thermal network analysis programs. The $\mathcal{F}$ is defined as follows:

$$\mathcal{F}_{I \rightarrow J} = \frac{q_{NET\ I \rightarrow J}}{\theta A_I \ (T_I^4 - T_2^4)}$$

For a gray diffuse emitter, diffuse reflector with constant properties the $\mathcal{F}$ can be obtained closed form. The method of solution most suitable for the Wang 2200 involves the use of matrix algebra. Derivation of the matrix formulas is fully explained in Reference 2.

The program requires as an input the following values:

1) Number of surfaces.
2) The area and emissivity of each surface (any units for the area may be used).
3) Half of the view factor matrix (the program calculates the other half through form factor algebra).

An example case would be the radiation network inside of a cube one foot on each side with all surfaces having an emitance of 0.5. The view factor between sides of a cube at 90 degrees to each other was calculated in the sample case for the "BLOCKF" program and is .20004. The view factor between opposing sides is .19984. Therefore, with 1 and 2 as the top and bottom and 3 through 6 as the sides of the cube, the view factor matrix would be as follows:

I	J	VIEW FACTOR
1	1	0
1	2	.19984
1	3	.20004
1	4	.20004
1	5	.20004
1	6	.20004
2	2	0
2	3	.20004
2	4	.20004
2	6	.20004
3	3	0
3	4	.20004
3	5	.19984
3	6	.20004

I	J	VIEW FACTOR
4	4	0
4	5	.20004
4	6	.19984
5	5	0
5	6	.20004
6	6	0

Figure 12 is the program output for the sample case. The program first prints out an image of the input data and the full view factor matrix. Next it prints out the $\mathcal{F}$ matrix.

A listing of the "SCRIPTF" program is included in Table X.

Reference 2

Wiebelt, John A., Engineering Radiation Heat Transfer, August, 1966, pages 115-121.

FIGURE 12

SCRIPTF SAMPLE CASE

SURF #	AREA	EMISS
1	1	.5
2	1	.5
3	1	.5
4	1	.5
5	1	.5
6	1	.5

F MATRIX

F(1 , 1)	0
F(1 , 2)	.19984
F(1 , 3)	.20004
F(1 , 4)	.20004
F(1 , 5)	.20004
F(1 , 6)	.20004
SUM F*100	100

F(2 , 1)	.19984
F(2 , 2)	0
F(2 , 3)	.20004
F(2 , 4)	.20004
F(2 , 5)	.20004
F(2 , 6)	.20004
SUM F*100	100

F(3 , 1)	.20004
F(3 , 2)	.20004
F(3 , 3)	0
F(3 , 4)	.20004
F(3 , 5)	.19984
F(3 , 6)	.20004
SUM F*100	100

F(4 , 1)	.20004
F(4 , 2)	.20004
F(4 , 3)	.20004
F(4 , 4)	0
F(4 , 5)	.20004
F(4 , 6)	.19984
SUM F*100	100

FIGURE 12 CONT.

```
F( 5 , 1 )    .20004
F( 5 , 2 )    .20004
F( 5 , 3 )    .19984
F( 5 , 4 )    .20004
F( 5 , 5 )   0
F( 5 , 6 )    .20004
SUM F*100    100

F( 6 , 1 )    .20004
F( 6 , 2 )    .20004
F( 6 , 3 )    .20004
F( 6 , 4 )    .19984
F( 6 , 5 )    .20004
F( 6 , 6 )   0
SUM F*100    100
```

SCRIPT F MATRIX

```
SF( 1 , 1 )    4.54545484E-02
SF( 1 , 2 )    9.08760336E-02
SF( 1 , 3 )    9.09173544E-02
SF( 1 , 4 )    9.09173544E-02
SF( 1 , 5 )    9.09173544E-02
SF( 1 , 6 )    9.09173544E-02
SUM SF/E *100    99.99999999978

SF( 2 , 1 )    9.08760336E-02
SF( 2 , 2 )    4.54545484E-02
SF( 2 , 3 )    9.09173544E-02
SF( 2 , 4 )    9.09173544E-02
SF( 2 , 5 )    9.09173544E-02
SF( 2 , 6 )    9.09173544E-02
SUM SF/E *100    99.99999999978
```

FIGURE 12 CONCLUDED

```
SF( 3 , 1 )    9.09173544E-02
SF( 3 , 2 )    9.09173544E-02
SF( 3 , 3 )    4.54545484E-02
SF( 3 , 4 )    9.09173544E-02
SF( 3 , 5 )    9.08760336E-02
SF( 3 , 6 )    9.09173544E-02
SUM SF/E *100    99.9999999998

SF( 4 , 1 )    9.09173544E-02
SF( 4 , 2 )    9.09173544E-02
SF( 4 , 3 )    9.09173544E-02
SF( 4 , 4 )    4.54545484E-02
SF( 4 , 5 )    9.09173544E-02
SF( 4 , 6 )    9.08760336E-02
SUM SF/E *100    99.99999999978

SF( 5 , 1 )    9.09173544E-02
SF( 5 , 2 )    9.09173544E-02
SF( 5 , 3 )    9.08760336E-02
SF( 5 , 4 )    9.09173544E-02
SF( 5 , 5 )    4.54545484E-02
SF( 5 , 6 )    9.09173544E-02
SUM SF/E *100    99.9999999998

SF( 6 , 1 )    9.09173544E-02
SF( 6 , 2 )    9.09173544E-02
SF( 6 , 3 )    9.09173544E-02
SF( 6 , 4 )    9.08760336E-02
SF( 6 , 5 )    9.09173544E-02
SF( 6 , 6 )    4.54545484E-02
SUM SF/E *100    99.99999999978
```

TABLE X

SCRIPTF PROGRAM LISTING

```
10 DIM A(24),E(24),B(24),S(24),F(24,24),C(24,24):N9=24
20 INPUT "NUMBER OF SURFACES",N:IF N>N9 THEN 20
30 MAT REDIM A(N),E(N),B(N),S(N),F(N,N),C(N,N)
40 FOR I=1 TO N
50 PRINT "SURFACE ";I;:INPUT " AREA,EMISS ",A(I),E(I)
60 NEXT I
70 FOR I=1 TO N:FOR J=I TO N
80 PRINT "F(";I;",";J;")";:INPUT F(I,J)
90 F(J,I)=F(I,J)*A(I)/A(J)
100 NEXT J:NEXT I
110 SELECT PRINT 215(120):PRINT :PRINT
120 PRINT "SURF #          AREA             EMISS"
130 FOR I=1 TO N:PRINT I,A(I),E(I):NEXT I:PRINT :PRINT
140 PRINT "  F MATRIX":PRINT :PRINT
150 FOR I=1 TO N:E7=0: FOR J=1 TO N
160 E7=E7+F(I,J)
170 PRINT "F(";I;",";J;")  ";F(I,J)
180 NEXT J:PRINT "SUM F*100  ";E7*100
190 PRINT :PRINT : NEXT I
200 PRINT :PRINT :PRINT :PRINT "  SCRIPT F MATRIX":PRINT :PRINT

210 FOR K=1 TO N
220 FOR I=1 TO N
230 B(I)=-A(I)*F(I,K)*E(K)
240 FOR J=1 TO N
250 D=1
260 IF I=J THEN 280
270 D=0
280 C(I,J)=(F(I,J)*(1-E(J))-D)*A(K)/A(J)/E(J)*A(I)
290 NEXT J :NEXT I
300 MAT C =INV (C)
310 MAT S=C*B
320 E7=0
330 FOR J=1 TO N
340 PRINT "SF(";K;",";J;")  ";S(J)
350 E7=E7+S(J)
360 NEXT J
370 PRINT "SUM SF/E *100  ";E7/E(K)*100
380 PRINT :PRINT
390 NEXT K
400 SELECT PRINT 005(64)
410 END
```

APPENDIX 1

DERIVATION OF CO_2 REMOVAL RATE FOR PROGRAM "LIOHCRT"

The test setup is shown in Figure 13 . The partial pressure of CO_2 is known at the ARS inlet and remains constant up to the LiOH canister inlets. Therefore, the problem reduces to the configuration shown in Figure 14 .

The LiOH chemical reaction is as follows:

$$2LiOH + CO_2\ (9) = Li_2\ CO_3 + H_2O\ (9)$$

Therefore, for each mole of CO_2 gas removed, approximately a mole of H_2O vapor is added to the gas stream. This is an approximation because a small amount of water vapor collects in the LiOH bed. Therefore,

$$n_1 \approx n_2$$

The ideal gas law shows:

$$\frac{\dot{V}}{T} = \frac{nMR}{P}$$

$$R = \frac{\bar{R}}{M}$$

$$\therefore \frac{\dot{V}}{T} = \frac{n\bar{R}}{P}$$

or

$$\frac{\dot{V}_1}{T_1} = \frac{n_1\bar{R}}{P_1}$$

$$\frac{\dot{V}_2}{T_2} = \frac{n_2\bar{R}}{P_2}$$

The total pressure across the LiOH bed remains approximately constant, therefore,

$$P_1 \approx P_2$$

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Since the number of moles, the total pressure, and remain constant across the LiOH bed,

$$\frac{\dot{V}_1}{T_1} = \frac{\dot{V}_2}{T_2}$$

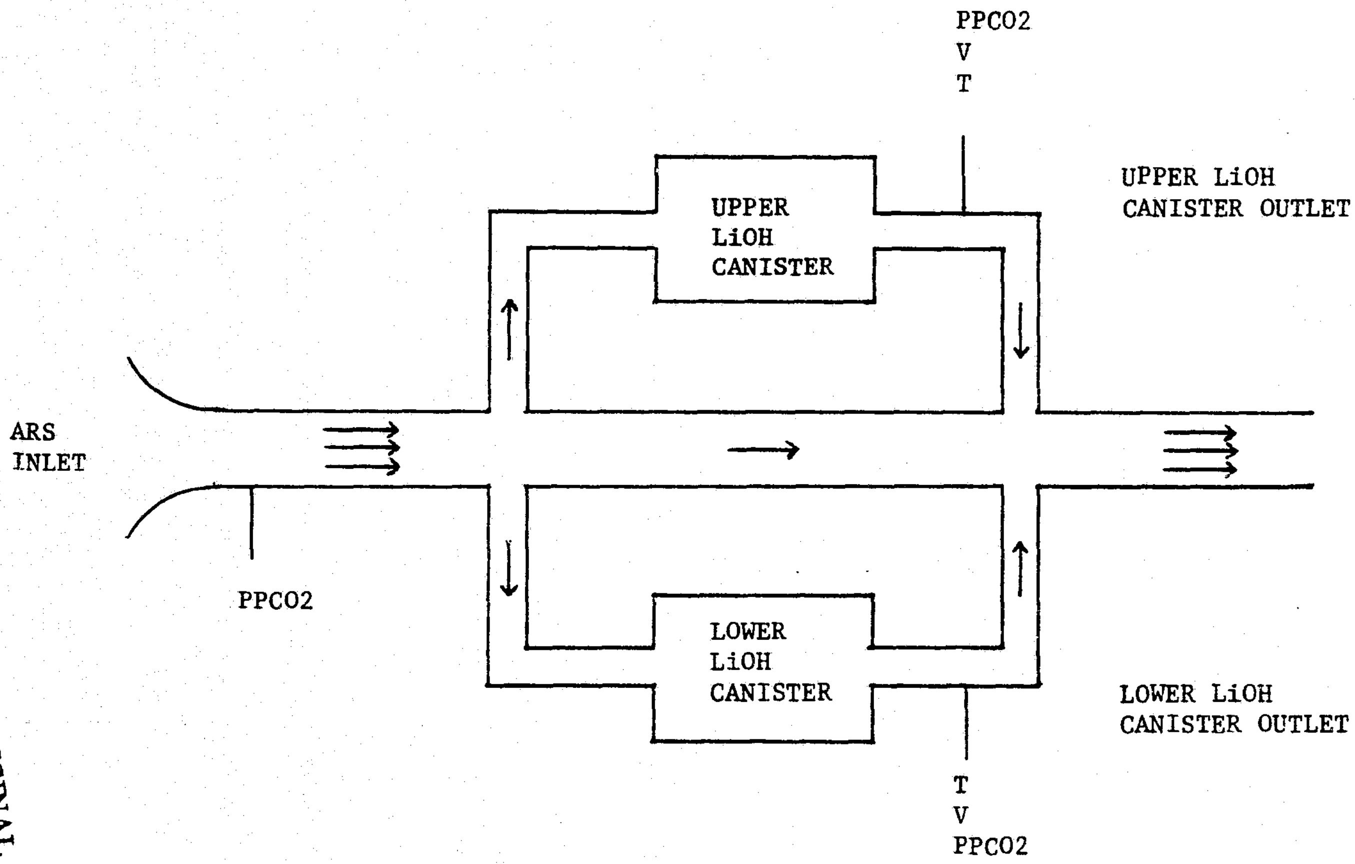

FIGURE 13 RSECS LiOH TEST CONFIGURATION

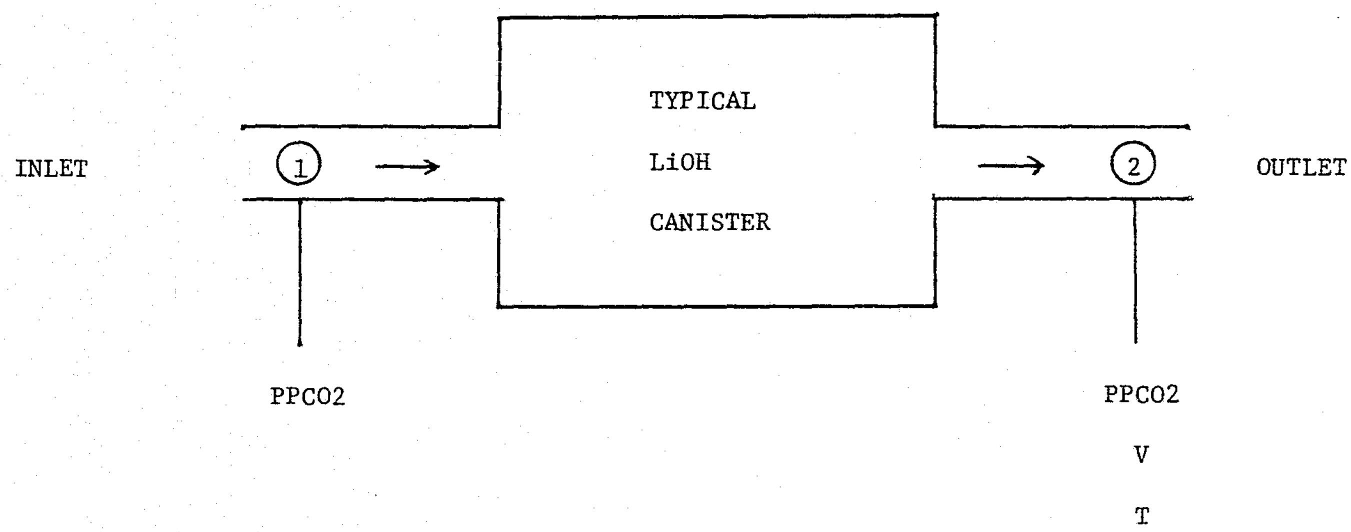

FIGURE 14 RSECS TYPICAL LiOH CANISTER CONFIGURATION

Developing the formula for CO_2 mass removal rate is as follows:

$$\Delta \dot{M}CO_2 \text{ (removed)} = \dot{M}CO_2 \text{ (at 1)} - \dot{M}CO2 \text{ (at 2)}$$

$$= \frac{PCO_{21}\ \dot{V}_1}{RCO_2\ \ T_1} - \frac{PCO_{2\ 2}\ \dot{V}_2}{RCO_2\ \ T_2}$$

but $\dfrac{\dot{V}_1}{T_1} = \dfrac{\dot{V}_2}{T_2}$

$$\therefore\ \Delta MCO_2 = \frac{\dot{V}_2}{RT_2}\ (PCO_{21} - PCO_{22})$$

$$RCO_2 = 35.1\ \frac{lb_f - ft}{lb_m - {}^oR}$$

$\dot{V}$ is in Ft^3/MIN

PCO_2 is in mmHg

$$\Delta \dot{M}CO_2 = \frac{\dot{V}\left(\frac{Ft^3}{MIN}\right) \cdot \Delta P\ (\text{mmHg}) \cdot \left(2.785\ \frac{lb_f/Ft^2}{mmHg}\right)}{35.1\ \left(\frac{ft-lb_f}{lbm-{}^oF}\right) \cdot\ (T+460)\ ({}^oR)}$$

$$\Delta \dot{M}CO_2 = 0.07931 * \dot{V} * \Delta P/(T+460) \text{ in lbm/min.}$$

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